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# SILT PROJECT, COLORADO

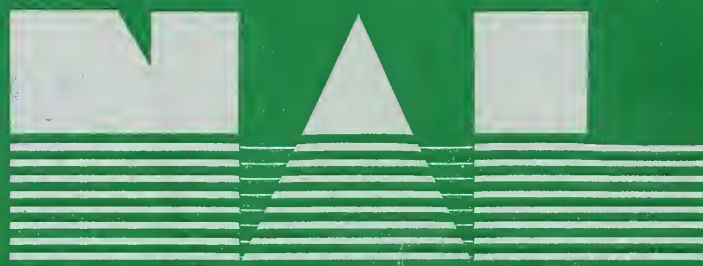
## COLORADO RIVER STORAGE PROJECT

*A* Report of reappraisal of  
direct agricultural bene -  
fits and project impacts



U. S. DEPARTMENT OF AGRICULTURE  
Salt Lake City, Utah

**United States  
Department of  
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REPORT OF

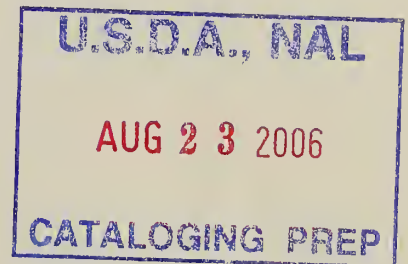
REAPPRAISAL OF DIRECT AGRICULTURAL BENEFITS

AND PROJECT IMPACTS

SILT PROJECT

COLORADO

COLORADO RIVER STORAGE PROJECT



In Cooperation With  
Bureau of Reclamation  
United States Department of the Interior

Report Prepared by

USDA Field Advisory Committee and USDA Field Party

Salt Lake City, Utah - August 1961



## ACKNOWLEDGMENTS

In preparing this report, full use was made of available field data, published reports, and the combined judgement of agricultural technicians familiar with the project area, its agricultural problems and conditions. The U. S. Bureau of Reclamation furnished the USDA Field Party with preliminary reports, land classification maps and field sheets, information regarding water supply and acreage and location of lands to be included in the project. This information was used to augment field investigations such as soil surveys, economic surveys, engineering surveys, crop yield determinations, and irrigation water investigations made by members of the USDA Field Party, Soil Conservation Service and Economic Research Service.

The U. S. Forest Service, U. S. Bureau of Land Management, and others assisted in the watershed studies. The Forest Service also prepared Chapter III regarding the relationship of the project to national forest lands. Assistance from representatives of the Colorado State University, Colorado Cooperative Extension Service, Colorado Agricultural Experiment Station, State and County Agricultural Stabilization and Conservation Committees, U. S. Farmers Home Administration, Agricultural Research Service, and others was valuable in preparing the report.

The contributions and assistance of these organizations in the preparation of this report are gratefully acknowledged.



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REPORT OF REAPPRAISAL OF DIRECT AGRICULTURAL  
BENEFITS AND PROJECT IMPACTS  
SILT PROJECT - COLORADO

SUMMARY

Authority

This report on the Silt participating project, Colorado River Storage Project, has been prepared by the U. S. Department of Agriculture in response to the President's letters of March 19, 1954 to the Secretary of Agriculture and the Secretary of the Interior. In his letters, the President requested that a reappraisal of the direct agricultural benefits, expected to be produced by the participating projects of the Colorado River Storage Project, be made by the Department of Agriculture in cooperation with the Department of the Interior. Following authorization of the Colorado River Storage Project by the Congress on April 11, 1956, an understanding was reached in July 1956 between the Secretary of Agriculture and Secretary of the Interior regarding conduct of a survey to reappraise direct agricultural benefits and to appraise project impacts. The Department of Agriculture survey was made under the authority of Section 6, Public Law 566, 83rd Congress, as amended, which authorizes the Department to cooperate with other Federal, State and local agencies to make investigations and surveys of the watersheds of rivers as a basis for the development of coordinated programs.

Purpose and Scope

The purpose of this report is to present information regarding the soil capabilities for irrigation, the present and future land use and production pattern, the costs associated with on-farm irrigation development, prospective size and type of farm, direct agricultural benefits and probable farm incomes with proposed irrigation development for the Silt project. In addition to the agricultural phases, this report deals with the impacts of the project on the national forests and the relationship of watershed conditions to the project.

This report also is intended to aid the Bureau of Reclamation in developing their Definite Plan Report, and to provide information bearing on the relationship of the project to the regular programs of the Department of Agriculture. It is based on the Silt project plan as outlined by the Bureau of Reclamation and is confined to the proposed project facilities and the project lands to which the Bureau of Reclamation plans to furnish irrigation water.

The assumptions made concerning the level of management and application of practices as a result of project development are not technical recommendations of the Department of Agriculture for the best land and water use on the project. It is assumed that the level of management and application of practices represent the average that will exist during the project evaluation period.





## General Description

The Silt project is located in southeastern Garfield County, Colorado. Elevation of project lands varies from 5,500 to 6,300 feet. The climate is semi-arid. Average annual precipitation approximates 11 inches. The average frost-free period varies from 128 to 141 days. Project lands are all privately owned and are located on Harvey and Davie Mesas and in Dry Elk Valley. Agriculture is the basic industry of the project area, with livestock production being the principal type of farming. Mining, railroading and recreation also are a part of the local economy.

## Proposed Project Development

The Silt project will furnish supplemental irrigation water for 4,479 acres of land presently irrigated with only a partial water supply and 2,118 acres of non-irrigated land. In addition, 244 acres of Bureau of Reclamation class 4 land and 226 acres of class 6W presently irrigated land will continue to receive their present water supplies.

The project plan proposes the construction of the Rifle Gap Dam and Reservoir on Rifle Creek and the Silt Pumping Plant located on the Colorado River. The reservoir will have an initial capacity of 12,650 acre-feet, including 9,500 acre-feet of active capacity for irrigation and 3,150 acre-feet inactive capacity for sediment, fish and wildlife. In addition to the dam and pumping plant, several canals and laterals, plus interceptor and outlet drains, will also be constructed as part of the project. The existing Harvey Gap Reservoir will continue to deliver water for use on lands on Harvey Mesa. The increase in water supplies provided by the project will be 5,030 acre-feet for presently irrigated lands and 6,700 acre-feet for new lands, a total of 11,730 acre-feet, at the point of diversion.

## Evaluation of Direct Agricultural Benefits

### Evaluation Areas

For purposes of the analysis, project lands were grouped into eight evaluation areas. The soils, climate and water supply within each evaluation area reflect similar crop adaptations, productivity, land and irrigation development and production costs. Estimates of farm incomes and direct agricultural benefits were developed for each area and for the project as a whole. These areas have been designated as A, B, C, D, E, F, G and H. Lands in evaluation areas A and B are geographically located on Harvey Mesa, lands in C and D are located on Davie Mesa and lands in E, F, G and H in Dry Elk Valley.

Evaluation Area A comprises 2,835 acres of presently irrigated land and 383 acres of new land. Soils are deep, medium to fine textured and have slopes ranging from 0-6 percent. Most of the project soils having saline, alkali and high water table problems are included in this evaluation area.





Evaluation Area B comprises 1,286 acres of presently irrigated land and 176 acres of new land. Soils are similar to those in evaluation area A but slopes are steeper, generally from 6-12 percent. Evaluation area B lands are intermingled with lands of evaluation area A.

With project development, presently irrigated lands in evaluation areas A and B will receive approximately an additional .9 acre-foot of water per acre delivered at the farm headgate. Intermingled non-irrigated new lands will receive 2.7 acre-feet of water delivered at the farm headgate.

Evaluation Area C consists of 657 acres of non-irrigated new lands to be served by the Davie Ditch. Soils are similar to those in evaluation area A on slopes from 0-6 percent. New farm units will be established on these lands.

Evaluation Area D comprises 215 acres of non-irrigated new lands to be served by the Davie Ditch. Soils and slopes are similar to those in evaluation area B. Crop distribution and crop yields will average the same as for evaluation area B.

Lands in evaluation areas C and D are presently non-irrigated. With project development they will receive approximately 2.7 acre-feet of water per acre delivered at the farm headgate.

Evaluation Area E is comprised of 181 acres of presently irrigated land located in Dry Elk Valley. Soils are deep with medium to fine textures, moderate to slow permeability, generally on slopes between 3 and 6 percent. Irrigation water will be delivered by direct diversion from East Rifle Creek.

Evaluation Area F consists of 177 acres of presently irrigated land located in Dry Elk Valley. Soils are similar to those in evaluation area E but slopes are steeper, generally from 6-12 percent.

With project development, lands in evaluation areas E and F will receive approximately an additional 1.9 acre-feet of irrigation water per acre delivered at the farm headgate.

Evaluation Area G comprises 341 acres of non-irrigated new land in Dry Elk Valley. Soils and slopes are similar to evaluation area E.

Evaluation Area H is composed of 346 acres of non-irrigated new land in Dry Elk Valley. Soils are similar to evaluation area E but slopes are steeper, generally from 6-12 percent.

Lands in evaluation areas G and H are presently non-irrigated. With project development they will receive approximately 2.7 acre-feet of water per acre delivered at the farm headgate.

### Soils

Basic soils data were obtained from a soil survey of the project area completed by the Soil Conservation Service. Laboratory data on project soils





were furnished by the Agricultural Research Service and the Cooperative Soil Survey Laboratories in Fort Collins, Colorado. Land classification field sheets and laboratory data were obtained from the Bureau of Reclamation.

Evaluation area A comprises 3,218 acres of which 71 percent are in capability class III and 29 percent in capability class II. The 1,462 acres in evaluation area B, 215 acres in evaluation area D, 177 acres in evaluation area F and the 346 acres in evaluation area H are all in capability class IV. Evaluation area C comprises 657 acres of which 62 percent are in capability class II and 38 percent in capability class III. Eighty-eight percent of the 181 acres in evaluation area E are in capability class III and 12 percent in capability class II. Evaluation area G comprises 341 acres of which 84 percent are in capability class III and 16 percent in capability class II.

It is concluded that soils comprising the 6,597 acres of land designated by the Bureau of Reclamation as the Silt Project, which have been interpretively grouped into capability classes II-1,400 acres, III-2,997 acres, and IV-2,200 acres, are suitable for cultivation under irrigation.

#### Irrigation Supplies and Requirements

Several studies of irrigation requirements have been made in the general vicinity of the Silt project. These data, with additional information supplied by personnel familiar with the area, were used in estimating irrigation water requirements. In the past the water supply has averaged about one-third of requirements in the Dry Elk Valley and about two-thirds of requirements on Harvey Mesa. Estimated water requirement at the farm headgate is 2.86 acre-feet per acre. Weighted future average on-farm irrigation efficiencies are estimated at 53 percent and weighted average net seasonal crop consumptive use at 18.2 inches.

The period 1937-60 was selected as the basis for project water supply studies. Project water supplies during a period of years of comparable precipitation and water yield would with project average 2.74 acre-feet per acre of irrigation water at the farm headgate, thus meeting 96 percent of the average water requirements of the project lands.

#### Land and Irrigation Development

Estimates of development costs for project lands were made by evaluation areas on the basis of the level of management expected on the project and the physical requirements of the soils and site conditions. They are consistent with anticipated irrigation efficiencies and expected crop yields.

Estimated costs include land leveling and the establishment of farm irrigation systems and associated requirements. Estimated on-farm drainage costs for a limited acreage of project lands with water table conditions are also included.





Weighted average development per acre of irrigable land is estimated as follows: evaluation area A, \$65.03; evaluation area B, \$26.07; evaluation area C, \$66.53; evaluation area D, \$52.37; evaluation area E, \$39.04; evaluation area F, \$26.90; evaluation area G, \$69.77; evaluation area H, \$37.92.

### Direct Agricultural Benefits and Potential Farm Incomes

The economic analysis of the proposed Silt irrigation project has two primary objectives: (1) an appraisal of direct agricultural benefits from project development, and (2) an appraisal of prospective farm incomes from representative sizes and types of farms considered most likely with the proposed irrigation development. Both of these analyses contribute to a general appraisal of the prospects for a successful, stable, irrigated agricultural economy. Farm incomes were estimated for five farm types, namely: range beef, grade-A dairy, feeder calves, farm flock of sheep, and cash-crop.

Project lands are expected to be used largely for the production of grain and forage crops. Sale of livestock and livestock products will likely be the predominant sources of agricultural income to project farmers.

The residual approach was used to estimate direct agricultural benefits from irrigation water. The total value of crop and pasture production was allocated to the various factors of production, except water, in accordance with their projected market prices with the residual being credited to the project as a direct benefit. For the 319 acres of project lands which presently have a full water supply from pumping, it is assumed that these lands would have direct agricultural benefits equal to the savings in present pumping costs, minus abandonment losses for present pumping equipment.

Estimates of returns with the project in the analysis are based on weighted averages of anticipated farm types and of sizes of 130 acres in evaluation area A, 135 acres in evaluation areas C and E, 140 acres in evaluation area G, 150 acres in evaluation area B, 155 acres in evaluation areas D and F, and 160 acres in evaluation area H. The annual equivalent value of direct agricultural benefits attributed to the project for the evaluation area lands are estimated at, A-\$16.22, B-\$7.83, C-\$25.68, D-\$14.62, E-\$14.64, F-\$11.92, G-\$27.15, and H-\$12.45 per acre. Direct agricultural benefits on present pump lands are estimated to be \$21.55 per acre. The weighted average for the entire 6,597 acres is \$15.85 per acre, or \$104,531 annually.

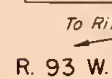
Development of the project will result in a more stable and profitable agricultural economy. For the sizes and types of farms analyzed, estimated farm incomes will vary from \$3,903 for a farm-flock sheep farm on evaluation area A lands to \$8,606 for a grade-A dairy farm on evaluation area C lands. The general conclusion from this analysis is that the income prospects for fully developed farms of the five types of farms analyzed are adequate to provide a satisfactory level of living and to make some payment for irrigation water.





SCALE IN MILES

Project Lands

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# SILT PROJECT

## CHAPTER I

### GENERAL INFORMATION

#### Organization

Pursuant to the U. S. Department of Agriculture Memorandum of Understanding between the Soil Conservation Service, Forest Service, and Agricultural Research Service (Economic Research Service) dated February 2, 1956, a USDA Field Advisory Committee, Colorado River Storage Project was established. The committee is composed of a representative from each of these agencies and a member representing the concerned state agricultural colleges. Principal duties of the committee are to maintain appropriate liaison and facilitate coordination of activities by the respective services and the state agricultural colleges in the survey. Field relationships with the Bureau of Reclamation and other interested State and Federal agencies are also a responsibility of the committee.

A USDA Field Party, working under direction of the USDA Field Advisory Committee and operating within a plan of work dated August 22, 1956, is headquartered at Salt Lake City, Utah. The party is responsible for the collection and analysis of data and the preparation of this report.

Applicable data from previous investigations were utilized in the study.

#### Description of the Area

##### Location and Physical Features

The Silt project is located in southeastern Garfield County, Colorado. The project area is bounded by the Colorado River on the south, the White River Plateau on the north, Elk Creek on the east and Rifle Creek on the west. Project lands are located generally in three areas, namely: Harvey Mesa, Dry Elk Valley and Davie Mesa. The town of Silt is located near the southeastern boundary of the project and the town of Rifle is located approximately three miles south and west of the southwestern boundary of the project. Elevation of project lands varies from 5,500 feet above sea level in the Davie and Harvey Mesa area to 6,300 feet above sea level in Dry Elk Valley.

Water for the project will be supplied from Rifle Creek by storage of surplus early season runoff in the proposed Rifle Gap Reservoir or the existing Harvey Gap Reservoir, and by exchange of natural flow water for stored water. Water will also be supplied to project lands from the Silt pumping plant located at Davis Point on the Colorado River. Rifle Creek is formed by its tributaries of East, Middle and West Rifle Creeks, which drain the White River Plateau and Coulter Mesa areas north of the Grand Hogback.

Project lands are all privately owned and are within the boundary of the Bookcliff Soil Conservation District.





From an irrigation agriculture standpoint, the topography of the area is extremely rough. More than half of the area consists of high mesa lands. Secondary mesas and alluvial fans lying below the higher mesas have excessive slopes and are cut by canyons and severely eroded gullies. These lower mesas and alluvial fans, together with the gentler sloping valley bottoms, furnish the greater part of the farming land.

Project soils have developed primarily from loess deposits over shale, sandstone and gravel outwash material. Other soils have developed in alluvium from Wasatch, Mancos and Mesa Verde sandstones and shales and undifferentiated loess and alluvium. They reflect the influence of their parent material and the semi-arid climate under which they were developed. Organic matter content is low; however, soils are generally deep and with additions of nitrogen and phosphorus are highly productive. Soils on Harvey Mesa and Davie Mesa have loam, silt loam, sandy clay loam and clay loam textures. Soils in Dry Elk Valley have clay loam and clay textures. In some areas where drainage is a problem, soils contain large enough accumulations of alkali salts to restrict crop production.

### Climate

The climate of the project area is temperate, semi-arid and is suitable for diversified irrigation farming. Relative humidity is low. Average annual precipitation recorded at Rifle (1931-1952) is 10.5 inches.

The average frost-free period for the Harvey Mesa area is estimated at 141 days, with the last killing frost occurring about May 13 and the first killing frost about September 30. The average frost-free period for Dry Elk Valley is estimated at 128 days. The last killing frost occurs about May 23 and the first killing frost about September 27.

### History of Settlement

In 1878 two prospectors from Leadville came into Garfield County and reported evidence of carbonate deposits. Settlement in the project area started in 1880 while western Colorado was still inhabited by the Ute Indians. In 1882 Garfield County was formed from part of Summit County and was named after President Garfield. The first fruit orchards were planted in 1888. Most of the early settlers were prospectors and miners who turned to agricultural pursuits after being unsuccessful in mining. First appropriations of water for irrigation were made in 1882 from streams tributary to the Colorado River.

### Agricultural Development

Agriculture is the basic industry of the project area. Crop production consists principally of hay and grain, most of which are used locally in the feeding of cattle, sheep, hogs and poultry. Small acreages of sugar beets, potatoes, corn and fruit are also grown. Presently irrigated lands in the project area experience irrigation water shortages after June of each year.





Dairy, range beef and sheep, feeder calf, farm flock of sheep and cash-crop farms comprise the bulk of the existing type of farms. These same types of farms are expected to prevail with project conditions. Adjacent national forest and public domain lands are used from spring, summer and fall grazing by cattle and sheep. Range rights on these lands are fully utilized and no additional grazing permits are available for any new farms developed by the project.

### Industrial Development

In addition to agriculture, several other industries contribute to the local economy. Mining is important in Garfield County. Seven workable coal veins, with a combined thickness of 100 feet, are located within a few miles of Rifle. The county has an estimated oil-shale deposit of 500 billion barrels of oil. The U. S. Bureau of Mines developed and operated a pilot oil-shale plant and mine six miles west of Rifle. This plant has now been turned over to the Navy Petroleum Reserves. The Union Oil Company of California is also active in the oil-shale development. They erected and operated, during the period of 1956-58, a three million dollar research extraction plant near Parachute Creek. During 1960 the plant was dismantled and shipped to South America for similar shale research. The Union Carbide Nuclear Company recently completed an eight and one-half million dollar uranium and vanadium mill at Rifle.

Recreation and railroading also provide the area with a substantial source of income.

### General

The towns of Rifle and Silt are both located on the main line of the Denver and Rio Grande Western Railroad, which operates between Denver and Salt Lake City, Utah. U. S. Highways 6 and 24 also connecting Denver and Salt Lake City, pass through Rifle and Silt. Colorado State Highway 13 extends north from Rifle to Meeker and Craig.

Census records show Garfield County with a population of 10,560 in 1940, 11,625 in 1950 and 12,017 in 1960. Population of Rifle was 1,373 in 1940, 1,525 in 1950 and 2,135 in 1960.

### Proposed Development

The Silt project plan proposes the construction of the Rifle Gap Dam and Reservoir on Rifle Creek, approximately seven miles above the town of Rifle. Surplus early season runoff will be stored in the reservoir. Approximately 80 percent of the water stored in the reservoir will be used to replace natural flow water now used to irrigate some 2,600 acres of land in the lower Rifle Creek Valley. The remainder of the water stored in the reservoir will be used to irrigate new lands on Davie Mesa and upper Cactus Valley. In exchange, natural flow of East Rifle Creek will be diverted above the proposed reservoir and used to irrigate lands in Dry Elk Valley



and Harvey Mesa. The existing Harvey Gap Reservoir will continue to store early season runoff delivered through the Grass Valley Canal from Rifle Creek for use on lands on Harvey Mesa. The Rifle Gap Reservoir will have a capacity of 12,650 acre-feet, including 9,500 acre-feet of active capacity for irrigation and 3,150 acre-feet of inactive capacity for sediment control and fish and wildlife.

Additional irrigation water for project lands will be pumped from the Colorado River by the Silt pumping plant located at Davis Point. This water will be delivered to project lands in the lower Harvey Mesa and lower Antlers and Cactus Valleys by the Silt pump canal. A portion of this area is currently receiving water through eight private pumping systems with lifts from the Cactus Valley Canal. The increase in water supplies provided by the project will be 5,030 acre-feet for presently irrigated lands and 6,700 acre-feet for new lands, a total of 11,730 acre-feet, at the point of diversion.

Irrigation water made available by the project will be used to irrigate 4,479 acres of land now irrigated with only a partial water supply and 2,118 acres of land not now irrigated. In addition, 244 acres of Bureau of Reclamation Class 4 land and 226 acres of class 6W presently irrigated land will continue to receive present water supplies. Several miles of interceptor and outlet drains will also be constructed as part of the project. Total acreage of project lands to receive water will be 6,597 acres.





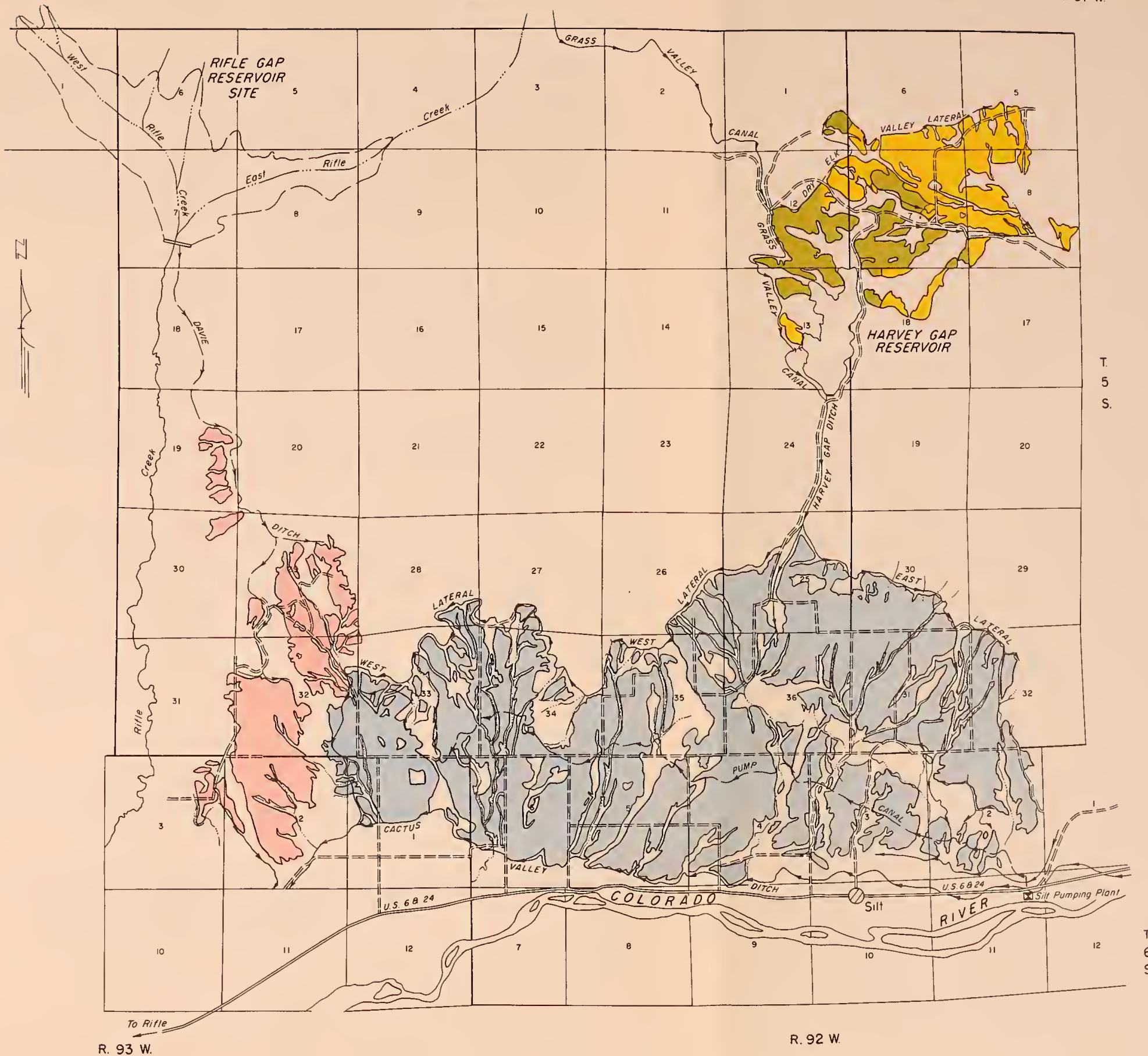


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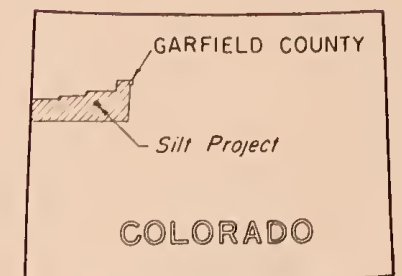
R. 91 W.

# EVALUATION AREA MAP SILT PROJECT GARFIELD COUNTY, COLORADO

JUNE 1961



## LEGEND



LOCATION MAP

R. 93 W.

R. 92 W.

7-E-16745-N





## CHAPTER II

### EVALUATION OF DIRECT AGRICULTURAL BENEFITS FROM THE SILT PROJECT

The evaluation of direct agricultural benefits for the project is based on the proposed facilities and the project lands to which the Bureau of Reclamation plans to furnish irrigation water. Intervening lands not included in the project are not considered in the report. The assumptions made concerning the level of management and application of practices as a result of project development are not technical recommendations of the Department of Agriculture for the best land and water use on the project. It is assumed that the level of management and application of practices represents the average that will exist during the project evaluation period.

#### Evaluation Areas - General Description

To facilitate the presentation of basic agricultural data and to assist in the analysis of direct agricultural benefits, project lands were grouped into evaluation areas. Soils, climate, and water supply within each evaluation area reflect similar crop adaptations, productivity, land and irrigation development and production costs.

Eight evaluation areas were established to represent conditions in the project area. These areas have been designated by the letters A, B, C, D, E, F, G and H. The acreage of each is shown in table 1.

Table 1. - Irrigable land acreage by evaluation areas, Silt project

| Project<br>Lands             | Evaluation Areas |            |            |            |                |          |            |            | Project<br>Total |
|------------------------------|------------------|------------|------------|------------|----------------|----------|------------|------------|------------------|
|                              | Harvey Mesa      |            | Davie Mesa |            | Dry Elk Valley |          |            |            |                  |
|                              | A                | B          | C          | D          | E              | F        | G          | H          |                  |
|                              | <u>Acres</u>     |            |            |            |                |          |            |            |                  |
| Presently irrigated<br>lands | 2,835            | 1,286      | -          | -          | 181            | 177      | -          | -          | 4,479            |
| Non-irrigated lands          | <u>383</u>       | <u>176</u> | <u>657</u> | <u>215</u> | <u>-</u>       | <u>-</u> | <u>341</u> | <u>346</u> | <u>2,118</u>     |
| Total Acreage                | 3,218            | 1,462      | 657        | 215        | 181            | 177      | 341        | 346        | 6,597            |

Evaluation areas A and B are located geographically on Harvey Mesa, evaluation areas C and D on Davie Mesa and evaluation areas E, F, G and H in Dry Elk Valley. The areas are described as follows:





### Evaluation Area A

Evaluation area A comprises 2,835 acres of presently irrigated land and 383 acres of new land. The new land is intermingled with presently irrigated land and will likely be used to enlarge existing operating units. Evaluation area A lands will receive water either by diversion from East Rifle Creek or by pump from the Colorado River.

The soils are deep, medium to fine textured, generally on slopes from 1 to 6 percent. They have medium water intake rates, moderate to slow permeability in subsoil and substratum and high water holding capacity. Most of the project soils having saline, alkali and high water table problems are included in this evaluation area. Proposed project drainage, supplemented by on-farm drainage, should correct these problems and result in crop yields equal to other lands in the evaluation area.

Lands within this evaluation area can be farmed intensively and will produce high yields. All of the sugar beets now grown in the project area are on these lands and the majority of the expanded acreage of sugar beets with the proposed project is expected to be on these lands.

Effectiveness of the past water supply has been increased by the improved distribution provided by use of the Harvey Gap Reservoir. There are 213 acres included within this evaluation area that have had a full water supply by pumping from Cactus Valley Ditch. Benefits on these lands will be calculated separately from the other lands in this evaluation area. Presently irrigated lands will receive approximately .9 acre-foot per acre of additional irrigation water and new lands will receive approximately 2.7 acre-feet per acre with development of the proposed project. Crop yields have been good but substantial improvement is expected from the additional water.

### Evaluation Area B

This evaluation area comprises 1,286 acres of presently irrigated land and 176 acres of new land. The new land is in small scattered tracts intermingled with presently irrigated land, and it is anticipated that the new lands will be added to existing farm units.

Evaluation area B lands are intermingled with lands of evaluation area A. It is very unlikely that a farm unit will have lands of evaluation area B only. Soils are similar to evaluation area A but slopes are steeper, generally from 6 to 12 percent.

A small acreage is affected with water table, salt and alkali. Another small acreage has stones on the surface. Project drainage is not planned for the wet areas, but farm drains may be installed by individual operators. It is not anticipated that drainage or stone removal will be applied to the degree to develop these lands to their maximum productive capacity.

Because of the steep slopes and the degree of development anticipated for these lands, types of crops will be restricted and crop yields will average lower than yields in evaluation area A. Cropping systems will include





alfalfa-grass hay, small grain, and grass legume pastures. With livestock as the principal enterprise, feed crops from these evaluation area B lands can usefully supplement more intensive cropping on evaluation area A lands within farm units.

Water supply has been the same as for evaluation area A and approximately .9 acre-foot per acre of additional water is expected with the proposed project development for presently irrigated lands. Intermingled non-irrigated new lands will receive 2.7 acre-feet of water delivered at the farm headgate. There are 106 acres included within this evaluation area that will be evaluated separately since they now have a full water supply pumped from Cactus Valley Ditch.

#### Evaluation Area C

This evaluation area consists of 657 acres of new lands to be served by the Davie Ditch. These lands have been farmed previously but are now abandoned. Soils are similar to those in evaluation area A and it is anticipated that they will produce similar crops and yields when irrigated. Water supply will come through Davie Ditch from the Rifle Gap Reservoir. Approximately 2.7 acre-feet of irrigation water per acre will be furnished these lands with project development. New farm units will be established because these lands are physically separated from presently irrigated areas.

#### Evaluation Area D

Evaluation area D comprises 215 acres of new land intermingled with evaluation area C lands also to be served by Davie Ditch. Irrigation water supply will be the same as evaluation area C. Soils and slopes are similar to evaluation area B. It is anticipated that these lands will have the same limitations in cropping as those in evaluation area B. Crop distribution and yields are projected to average the same as for evaluation area B. New units established on lands of evaluation area D will likely include some lands in evaluation area C.

#### Evaluation Area E

Evaluation area E is comprised of 181 acres of presently irrigated land located in Dry Elk Valley. Soils in this evaluation area are deep with medium to fine textures, moderate to slow permeability, generally on slopes between 3 and 6 percent. A small acreage of land has a high water table which should be corrected by the proposed project drainage.

Evaluation area E lands will be served by direct diversion of irrigation water in the Grass Valley Canal from East Rifle Creek. Average water supply with project development is anticipated to be the same as for other evaluation areas. The proposed project will supply approximately 1.9 acre-feet per acre additional irrigation water to these lands.





Crop distribution will be similar to evaluation area A and average crop yields will be slightly lower due to the estimated shorter growing season.

#### Evaluation Area F

Evaluation area F is comprised of 177 acres of presently irrigated land located in Dry Elk Valley, interspersed with lands of evaluation area E. Soils are similar to evaluation area E but slopes are steeper (6 to 12 percent). There is a small acreage of wet land but it is anticipated that the proposed project drainage will correct this condition.

Lands in this evaluation area will also be served by direct diversion into the Grass Valley Canal from East Rifle Creek. The proposed project will supply approximately 1.9 acre-feet per acre additional irrigation water to these lands.

It is anticipated that the same crop distribution will occur on these lands as on lands of evaluation area B. Crop yields are estimated slightly lower than those in evaluation area B. The differences in crop yields will be similar to those between evaluation areas A and E.

#### Evaluation Area G

This evaluation area comprises 341 acres of new land in Dry Elk Valley. Soils and slopes are similar to evaluation area E. Climate and crop yields with project are the same as for evaluation area E. Water to be furnished by the proposed project is approximately 2.7 acre-feet per acre.

#### Evaluation Area H

Evaluation area H is comprised of 346 acres of new land in Dry Elk Valley. Soils and slopes are similar to those in evaluation area F. Climate and crop yields with project are the same as evaluation area F. Water supply to be furnished by the proposed project is approximately 2.7 acre-feet per acre.

### Soils Inventory

#### Sources of Data

Soil information used in the reappraisal of the Silt project was obtained from the Soil Conservation Service, Agricultural Research Service and Bureau of Reclamation. A soil survey of the project was completed by the Soil Conservation Service. Laboratory data on project soils were furnished by the Agricultural Research Service and the Cooperative Soil Survey Laboratories in Fort Collins, Colorado. The Bureau of Reclamation supplied land classification field sheets and laboratory data on the chemical and physical properties of project soils. Information on water intake rates of soils was obtained from cylinder infiltrometer tests on selected sites of dominant soils.





## General Description of Soils and Soil Problems

More than half the project acreage is comprised of soils that have developed in loess over sandstone shale and gravel outwash material. The remaining acreage is composed of soils which have developed from alluvium or undifferentiated loess and alluvium.

Generally, the soils are deep, medium to fine textured, are high in silt and low in organic matter, have moderate to slow permeability and have a high water-holding capacity. Project soils generally have a moderate capacity to hold nutrients and require additions of nitrogen and phosphorus to obtain good yields of adapted crops. Slopes range from less than 1 to 12 percent, with the majority between 4 and 12 percent. Erosion is slight to moderate.

Although local in nature, salinity, alkali and high water table are problems in all geographic areas of the project where land is presently irrigated. These coexisting problems can be reduced, if not eliminated, by improving on-farm irrigation and improving drainage by providing adequate outlets and keeping outlets free of vegetation to allow a free flow of excess water. The Bureau of Reclamation plans to provide project drainage (digging new outlets and cleaning out natural drainageways) for areas in which there is a concentration of these problems.

With the moderate to high silt content of these soils and slopes from 1 to 12 percent, there is a general problem of soil erosion which can be kept to a minimum with applicable soil and water conservation practices. The fine textured soils require special management or a refinement of soil management practices to prevent puddling and compaction from tillage equipment, which take considerable time to correct.

Factors affecting the capability classification of soils in this project are climate, fine surface texture, degree of salt, alkali, water table, stoniness, and percent slope. The acreage of land capability units within each evaluation area and soil and water relationships are shown in table 2. Project acreage and general soil characteristics for each land capability unit are shown in table 3. These units, tabulated by evaluation areas, allow a general appraisal to be made of each evaluation area and of differences between evaluation areas.

Soils in capability class II have some limitations that reduce the choice of plants or require moderate conservation practices. Soils in capability class III have severe limitations that reduce the choice of plants or require special conservation practices or both. Soils in capability class IV have severe limitations that restrict the choice of plants or require very careful management or both.



Table 2. - Generalized soil-water relationship and acreages of land capability units by evaluation areas, Silt Project

| Evaluation Areas    | Land        | Acres | % Slope | Soil Depth : Inches | Water-holding Capacity  |                          | Remarks  |
|---------------------|-------------|-------|---------|---------------------|-------------------------|--------------------------|--|
|                     | Capa-       |       |         |                     | Inches per foot of soil | Total inches for profile |  |
|                     | bility Unit |       |         |                     |                         |                          |  |
| A                   | IIc         | 48    | 0-1     | 60+                 | 2.0                     | 10+                      | Some soils underlain by gravel between 30 and 48"  |
|                     | IIIs        | 10    | 0-1     | 60+                 | 2.0                     | 10+                      |  |
|                     | IIe         | 493   | 1-3     | 60+                 | 1.7                     | 8+                       |  |
|                     | IIes        | 6     | 1-3     | 60+                 | 2.0                     | 10+                      |  |
|                     | IIes1       | 19    | 1-3     | 60+                 | 2.0                     | 10+                      |  |
|                     | IIes2       | 297   | 1-3     | 60+                 | 2.0                     | 10+                      |  |
|                     | IIes1s1     | 43    | 1-3     | 60+                 | 2.0                     | 10+                      |  |
|                     | IIIs1       | 13    | 1-3     | 60+                 | 2.5                     | 12+                      |  |
|                     | IIIs2       | 113   | 1-3     | 60+                 | 2.0                     | 10+                      |  |
|                     | IIIs3       | 2     | 1-3     | 60+                 | 2.5                     | 12+                      |  |
|                     | IIe         | 1,883 | 3-6     | 60+                 | 2.0                     | 10+                      |  |
|                     | IIIs        | 38    | 3-6     | 60+                 | 2.0                     | 10+                      |  |
|                     | IIIs1       | 9     | 3-6     | 60+                 | 2.5                     | 12+                      |  |
|                     | IIIs2       | 188   | 3-6     | 60+                 | 2.0                     | 10+                      |  |
|                     | IIIs3       | 56    | 3-6     | 60+                 | 2.5                     | 12+                      |  |
| Total Acres (A)     |             | 3,218 |         |                     |                         |                          |  |
| B                   | IVs2        | 21    | 3-6     | 60+                 | 2.0                     | 8+                       | Some soil underlain by gravel at 48"   |
|                     | IVs3        | 8     | 3-6     | 60+                 | 2.5                     | 12+                      |  |
|                     | IVs4        | 103   | 3-6     | 60+                 | 1.7                     | 8+                       | Gravel between 20 and 48"  |
|                     | IVs5        | 19    | 3-6     | 60+                 | 1.5                     | 3+                       | Shallow to gravel  |
|                     | IVe         | 64    | 6-12    | 60+                 | 2.0                     | 9+                       | Some soils overlying gravel at 30 to 48"   |
|                     | IVe1        | 1,000 | 6-12    | 48-60+              | 2.0                     | 10+                      | Some soils underlain by gravel between 30 and 48" - some with shale at 48"   |
|                     | IVe2        | 24    | 6-12    | 60+                 | 2.0                     | 10+                      |  |
|                     | IVe4        | 223   | 6-12    | 60+                 | 1.7                     | 7+                       | Much of soil underlain by gravel between 20 and 48"  |
| Total Acres (B)     |             | 1,462 |         |                     |                         |                          |  |
| C                   | IIe         | 280   | 1-3     | 60+                 | 2.0                     | 10+                      | Small area of soil underlain by gravel between 20 and 36" Gravel at 48"  |
|                     | IIes2       | 127   | 1-3     | 60+                 | 2.0                     | 10+                      |  |
|                     | IIe         | 244   | 3-6     | 60+                 | 2.0                     | 10+                      |  |
|                     | IIIs2       | 6     | 3-6     | 60+                 | 2.0                     | 8+                       |  |
| Total Acres (C)     |             | 657   |         |                     |                         |                          |  |
| D                   | IVe         | 101   | 6-12    | 60+                 | 2.0                     | 9+                       | Some soils underlain by gravel between 20 and 48"  |
|                     | IVe1        | 69    | 6-12    | 60+                 | 2.0                     | 10+                      |  |
|                     | IVe4        | 45    | 6-12    | 60+                 | 2.0                     | 10+                      |  |
| Total Acres (D)     |             | 215   |         |                     |                         |                          |  |
| E                   | IIe         | 21    | 1-3     | 60+                 | 2.0                     | 10+                      |  |
|                     | IIIs        | 10    | 1-3     | 60+                 | 2.0                     | 10+                      |  |
|                     | IIe         | 112   | 3-6     | 60+                 | 2.0                     | 10+                      |  |
|                     | IIIs1       | 38    | 3-6     | 60+                 | 2.0                     | 10+                      |  |
| Total Acres (E)     |             | 181   |         |                     |                         |                          |  |
| F                   | IVs         | 5     | 1-3     | 60+                 | 2.5                     | 12+                      | Small acreage underlain by shale at depths between 36 and 60" Much of soils underlain by gravel between 20 and 48" Gravel at 20" - moderately stony soil |
|                     | IVs3        | 27    | 3-6     | 60+                 | 2.5                     | 12+                      |  |
|                     | IVs4        | 5     | 1-3     | 60+                 | 2.0                     | 10+                      |  |
|                     | IVe1        | 113   | 6-12    | 36-60+              | 1.7                     | 7+                       |  |
|                     | IVe2        | 9     | 6-12    | 60+                 | 2.0                     | 10+                      |  |
|                     | IVe4        | 18    | 6-12    | 60+                 | 1.7                     | 3+                       |  |
|                     |             |       |         |                     |                         |                          |  |
| Total Acres (F)     |             | 177   |         |                     |                         |                          |  |
| G                   | IIe         | 56    | 1-3     | 60+                 | 2.0                     | 9+                       | Some soils underlain by gravel between 36 and 60"  |
|                     | IIIs        | 39    | 1-3     | 60+                 | 2.0                     | 10+                      |  |
|                     | IIe         | 179   | 3-6     | 60+                 | 2.0                     | 9+                       | Some soils underlain by gravel between 36 and 60"  |
|                     | IIIs1       | 67    | 3-6     | 60+                 | 2.5                     | 12+                      |  |
| Total Acres (G)     |             | 341   |         |                     |                         |                          |  |
| H                   | IVs1        | 92    | 3-6     | 60+                 | 2.5                     | 12+                      | These soils are shallow to deep over gravel but all are deep to underlying rock  |
|                     | IVe1        | 175   | 6-12    | 60+                 | 1.7                     | 7+ (                     |  |
|                     | IVe2        | 38    | 6-12    | 60+                 | 2.0                     | 5+ )                     |  |
|                     | IVe4        | 41    | 6-12    | 60+                 | 1.7                     | 3+ (                     |  |
| Total Acres (H)     |             | 346   |         |                     |                         |                          |  |
| TOTAL PROJECT ACRES |             | 6,597 |         |                     |                         |                          |  |





### Evaluation Area A - Soils

This area is comprised of deep, medium to fine textured soils on slopes ranging from 0 to 6 percent. They have weakly to strongly developed B horizons with corresponding moderate to slow permeability. About 17 percent of the acreage consists of soils underlain by gravel at depths between 20 and 48 inches. Depth to shale is over 60 inches. Most of the project soils having saline, alkali and high water table problems, are included in this evaluation area. There are 2,302 acres or 71 percent of soils grouped into capability class III and 916 acres or 29 percent grouped into capability class II.

### Evaluation Area B - Soils

Soils in this evaluation area are generally deep, predominantly medium textured, have weakly to strongly developed B horizons, moderate to slow permeability, and slopes ranging from 3 to 12 percent. Thirty-five percent of this acreage consists of soils underlain by gravel between 12 and 48 inches. Depth to shale is over 60 inches. A small acreage is affected by salt, alkali, high water table and flooding. This evaluation area includes most of the moderately stony soils on the project. Steep slope is the major soil problem affecting the capability classification. All the soils comprising the 1,462 acres in this evaluation area are grouped into capability class IV.

### Evaluation Area C - Soils

Soils of this evaluation area have developed primarily from loess; however, a small acreage has developed from alluvium. They are deep, medium textured soils with weakly to strongly developed B horizons, moderate to slow permeability, and slopes ranging from 1 to 6 percent. A small acreage of soils is underlain by gravel at depths between 30 and 48 inches. Slope as it affects the soil erosion potential is the only significant problem affecting the capability classification of these soils. There are 407 acres or 62 percent of the soils grouped into capability class II and 250 acres or 38 percent grouped into capability class III.

### Evaluation Area D - Soils

This evaluation area is comprised of deep, medium textured soils which predominantly have weakly developed B horizons, moderate permeability, and slopes ranging from 6 to 12 percent. A small acreage of soils, representing about 13 percent of this area, is underlain by gravel at depths between 20 and 48 inches. Except for a small acreage that is slightly affected by salt and alkali, the only soil problem is slope as it affects the soil erosion potential. All the soils in this evaluation area (215 acres) are grouped into capability class IV.





### Evaluation Area E - Soils

Soils of this evaluation area are deep with medium to fine texture, moderate to slow permeability, and slopes ranging from 1 to 6 percent. There is a small acreage with a high water table problem but slope, as it affects the soil erosion potential, is the significant criterion for capability classification of these soils. There are 160 acres or 88 percent of the soils in capability class III and 21 acres or 12 percent in capability class II.

### Evaluation Area F - Soils

This evaluation area is comprised of deep, medium to fine textured soils with moderate to slow permeability. Slopes range from 1 to 12 percent, but the majority of the soils have slopes ranging from 6 to 12 percent. About 50 percent of the acreage is underlain by gravel between 20 and 48 inches. There are a few acres of soil with saline, alkali and water problems. Also, there is a small acreage of moderately stony soils. However, the major problem affecting the capability classification of these soils is moderately steep slopes. All the soils, comprising the 171 acres, in this evaluation area are grouped into capability class IV.

### Evaluation Area G - Soils

This evaluation area is comprised of deep, medium to fine textured soils with moderate to slow permeability and slopes ranging from 1 to 6 percent. About 25 percent of the acreage is underlain by gravel at a depth of 48 inches. The major problem significant to the capability classification of soils is slope as it effects the soil erosion potential. There are 285 acres or 84 percent of the soils grouped into capability class III and 56 acres or 16 percent grouped into capability class II.

### Evaluation Area H - Soils

Soils comprising this evaluation area are deep with medium to fine texture, moderate to slow permeability, and slopes ranging from 3 to 12 percent. About 40 percent of the acreage is underlain by gravel at depths between 20 and 48 inches. There is a small acreage which is moderately stony, but the soil problems significant to capability classification are fine textures and moderately steep slopes. All the soils in this evaluation area (346 acres) are grouped into capability class IV.

### Findings

It is concluded that soils comprising the 6,597 acres of land designated by the Bureau of Reclamation as the Silt Project, which have been interpretively grouped into capability classes II-1,400 acres, III-2,997 acres, and IV-2,200 acres, are suitable for cultivation under irrigation.





## Irrigation Requirements and Water Supplies

### Sources of Data

Reports on several studies include estimates of irrigation requirements in the general vicinity of the Silt project. Included are the following: (1) Appendix B of the Record of the Upper Colorado River Basin Compact Commission; (2) Consumptive Use of Water in the Irrigated Areas of the Upper Colorado River Basin, by Blaney and Criddle; and (3) Consumptive Use and Irrigation Water Requirements of Crops in Colorado, by Blaney and Criddle. Additional related information is contained in the Water Supply Papers of the U. S. Geological Survey, Climatological Data by the U. S. Weather Bureau, Colorado Heat and Moisture Indexes for Use in Land Capability Classification by the Soil Conservation Service, and other publications. These and other available related reports were carefully reviewed for the purpose of this study. In addition, information was supplied by technicians of the Colorado State University, Colorado Agricultural Experiment Station, Colorado Cooperative Extension Service, Colorado State Engineer, Agricultural Research Service, U. S. Bureau of Reclamation, U. S. Soil Conservation Service, and others familiar with the area.

### Water Requirements

Consumptive use requirements for the principal crops in the area were estimated by the Blaney-Criddle procedures (table 4). Long climatological records are available for the town of Rifle, located adjacent to the project area; however, there are material differences in elevation between Rifle and the several parts of the project. Some adjustment of both the temperature and precipitation records at Rifle is necessary, therefore, before they can be considered representative of the project area. There are no data available to guide estimates of the amount of adjustment needed. In addition, considerable variation of elevation occurs within the various parts of the project area. Considering these limitations, a refined and detailed estimate of consumptive use within the project area was not attempted. From inspection of the area and discussions with technicians familiar with the area, it appears that the Davie Mesa-Harvey Mesa area could be reasonably considered as one unit for purposes of estimating the consumptive use requirements, and the Dry Elk Valley as a separate unit.

Estimates of mean temperatures for the two project areas described above were made by application of standard adiabatic lapse rates,  $3^{\circ}$  per 1,000 feet, for the elevational differences, to the average mean temperature at Rifle as given by the U. S. Weather Bureau, Bulletin W, Supplement 11-5 (1931-1952).

For the purpose of this study, effective precipitation is considered to be 85% of the average precipitation for the ten driest consecutive years (1931-1940). Extension of the precipitation record at Rifle to the project area was difficult in the absence of data on the variability within the area. The Dry Elk Valley presents considerable uncertainty, as it is reputed to be at least partially in an area of "rain shadow" north and east of the Grand Hogback.





Table 4. - Estimate of consumptive use requirements for major crops, Silt project

|   | : Alfalfa : | : Clover & Grass : | : Corn : | : Small Grain : | : Sugar : |
|---|-------------|--------------------|----------|-----------------|-----------|
|   | : Pasture : |                    |          |                 | : Beets : |
| <u>Davie and Harvey Mesas,</u>                        |             |                    |          |                 |           |
| <u>Evaluation Areas A,B,C and D</u>                   |             |                    |          |                 |           |
| <u>Frost-free Period</u>                              |             |                    |          |                 |           |
| Consumptive use coefficient                           | .85         | .80                | .75      | .75             | .70       |
| Consumptive use factor                                | 28.78       | 28.78              | 26.47    | 20.61           | 28.78     |
| Consumptive use, Inches                               | 24.46       | 23.02              | 19.85    | 15.45           | 20.15     |
| <u>Nonfrost-free Period</u>                           |             |                    |          |                 |           |
| Consumptive use coefficient                           | .70         | .65                | -        | -               | -         |
| Consumptive use factor                                | 4.87        | 4.87               | -        | -               | -         |
| Consumptive use, Inches                               | 3.41        | 3.16               | -        | -               | -         |
| Total Consumptive Use, Ac. Ins./Acre                  | 27.87       | 26.18              | 19.85    | 15.45           | 20.15     |
| Effective Seasonal Precipitation, Inches              | 4.84        | 4.84               | 3.40     | 2.32            | 4.07      |
| Net Irrigation Requirement, Ac. Ins./Acre             | 23.03       | 21.34              | 16.45    | 13.13           | 16.08     |
| <u>Dry Elk Valley, Evaluation Areas E,F,G &amp; H</u> |             |                    |          |                 |           |
| <u>Frost-free Period</u>                              |             |                    |          |                 |           |
| Consumptive use coefficient                           | .85         | .80                | .75      | .75             | .70       |
| Consumptive use factor                                | 25.52       | 25.52              | 24.47    | 19.98           | 25.52     |
| Consumptive use, Inches                               | 21.69       | 20.41              | 18.35    | 14.99           | 17.86     |
| <u>Nonfrost-free Period</u>                           |             |                    |          |                 |           |
| Consumptive use coefficient                           | .70         | .65                | -        | -               | -         |
| Consumptive use factor                                | 6.76        | 6.76               | -        | -               | -         |
| Consumptive use, Inches                               | 4.73        | 4.39               | -        | -               | -         |
| Total Consumptive Use, Ac. Ins./Acre                  | 26.42       | 24.80              | 18.35    | 14.99           | 17.86     |
| Effective Seasonal Precipitation, Inches              | 5.50        | 5.50               | 3.90     | 2.74            | 4.22      |
| Net Irrigation Requirement, Ac. Ins./Acre             | 20.92       | 19.30              | 14.45    | 12.25           | 13.64     |





From an inspection of the area and a consideration of the lapse rates, it was concluded that the effective precipitation of the Davie Mesa-Harvey Mesa area will approximate the average precipitation (ten driest consecutive years) at Rifle, and the corresponding monthly amounts have accordingly been used. For an estimate of precipitation in the Dry Elk Valley, a correlation was developed between the records at Rifle and those at Collbran, the nearest station with similar characteristics and located at near the same elevation as the Dry Elk Valley.

The various irrigation water losses expected within the project at the projected level of land development under project operations were estimated by considering soil characteristics and site locations. Due allowance was made for leaching requirements for salt balance control. Resulting irrigation efficiency estimates were adjusted to reflect an estimated 12 percent reuse of tail water runoff and return flows as is the general practice within the area at present. Total farm irrigation water requirements were estimated by adding on-farm losses to the basic consumptive use estimates weighted by projected crop acreage distribution (table 5).

Table 5. - Irrigation requirements by evaluation areas, Silt project

| Evaluation Area | : Weighted Average :<br>: Consumptive Use :<br>: Requirements, :<br>: Acre-Inches per :<br>: Irrigable Acre : | : Weighted Average :<br>: Farm Irrigation :<br>: Efficiency, With :<br>: Project :<br>: Percent : | : Farm Headgate Water :<br>: Delivery Requirement, :<br>: Acre Inches per :<br>: Irrigable Acre : |
|-----------------|---|---|---|
| A               | 18.4  | 55  | 33.5  |
| B               | 18.6  | 49  | 38.0  |
| C               | 18.3  | 56  | 32.7  |
| D               | 18.4  | 49  | 37.6  |
| E               | 17.5  | 55  | 31.8  |
| F               | 17.3  | 50  | 34.6  |
| G               | 16.5  | 55  | 30.0  |
| H               | 16.6  | 51  | 32.6  |





## Adequacy of Water Supply

Irrigation water for the Silt project is now supplied by direct diversion of the natural flows of East Rifle Creek, supplemented by releases from the existing Harvey Gap Reservoir. This reservoir is filled during the winter and spring months when stream flows exceed the needs of downstream users. Lands in the Dry Elk Valley are upstream from the Harvey Gap Reservoir and hence receive water only by direct diversions from East Rifle Creek. During the spring snow-melt period, the flow in the creek is usually greatly in excess of the irrigation requirements for all lands which use it, both project and non-project. By early summer, however, the flow diminishes rapidly and is insufficient to meet the irrigation demands. As a result, the Dry Elk Valley lands with their junior water rights are unable to obtain irrigation water subsequent to midsummer, and crop yields are adversely affected. Bureau of Reclamation operations studies indicate that the total historical supply available to the presently cultivated land in Dry Elk Valley has amounted only to about 35 percent of seasonal requirements on an ideal demand basis for a normal rotation cropping pattern.

Lands on Davie Mesa have previously been subjugated and placed under irrigation. Irrigation water was diverted directly from Rifle Creek near the Rifle Gap Reservoir site. The available water rights were of such low priority, however, that insufficient irrigation water was available and the supply was undependable. Natural precipitation is inadequate for dry farming, hence successful farming is not possible without an adequate supply of irrigation water, and these lands were abandoned.

Lands on Harvey Mesa comprise the greater part of the project, some 4,680 out of the total of 6,597 acres. These lands are supplied by direct diversions during the early part of the irrigation season when the flow of East Rifle Creek is adequate, and by releases of stored water from Harvey Gap Reservoir during the latter part of the season when their natural flow rights are junior to those of downstream users on Rifle Creek. Total seasonal water supplies available to these lands have averaged substantially less than requirements. Most severe shortages have occurred during July and August, and in a number of years the water available during these months has been less than 20 percent of requirements. Bureau of Reclamation operations studies indicate that the average seasonal water supply available to lands under the Harvey Gap Reservoir has been about 69 percent of estimated requirements. There have been few years during which all water requirements have been completely satisfied. In the 24-year study period, only four years had seasonal water supplies greater than 90 percent of ideal requirements, while in 12 years the supply was less than 60 percent of requirements.

In recent years, some 326 acres of land on the lower part of Harvey Mesa, including 7 acres of non-project land, have been irrigated by pumping from the adjacent Cactus Valley Canal, which originates by direct diversion from the Colorado River. These lands have had essentially a full water supply and, accordingly, have been analyzed separately in the economic studies. Under project operations, they would receive their water supply from project sources.





Project plans propose the construction of three principal elements, (1) Rifle Gap Dam and Reservoir on Rifle Creek, (2) Davie Ditch, and (3) Silt pumping plant and canal. In addition, several canals and laterals and interceptor and outlet drains will also be constructed.

The Rifle Gap Reservoir will provide seasonal regulation of the flows of Rifle Creek. Exchange of stored water in the reservoir for natural flow rights held by downstream users will permit the increased diversion of late season flows into the Grass Valley Canal serving Dry Elk Valley and Harvey Mesa and thereby supplement the water supply for those areas.

Water for Dry Elk Valley will be supplied by direct diversion of the unregulated flows of East Rifle Creek through the Grass Valley Canal, in exchange for water stored in Rifle Gap Reservoir. Senior water rights below the Rifle Gap Reservoir will require bypassing natural flows during periods when no storage water is available in the reservoir for exchange. Since there will be no regulation of East Rifle Creek above the diversion point of the Grass Valley Canal, the water supply for the Dry Elk Valley will be affected by such bypasses.

The Rifle Gap Reservoir will provide essentially a full water supply for lands to be served by the Davie Ditch, while also ensuring that the senior rights of water users in the lower Rifle Creek Valley will be satisfied. Davie Ditch will convey water from the Rifle Gap Reservoir to serve the lands on Davie Mesa.

The Silt pumping plant will divert directly from the Colorado River and deliver to the proposed pump canal, which will distribute the water to about 1,804 acres of project lands on Harvey Mesa and a small acreage of interspersed non-project lands with water rights. The water supplied by this pumping plant and canal will supplement direct diversions from East Rifle Creek and gravity releases from Harvey Gap Reservoir. Use of pump water in exchange for gravity flow water in the area below the pump canal will equalize the water supply and minimize water shortages for lands in the Harvey Mesa service area. There are 4,680 acres of project lands, comprising evaluation areas A and B, and 358 acres of interspersed non-project lands with water rights which must be satisfied, a total of 5,038 acres, on Harvey Mesa.

Project operations studies assume that water supplies and project impacts will be equalized in the Harvey Mesa service area. It is fully recognized that farms lying below the Silt pump canal could, if desired, and by payment of the extra pumping costs involved, obtain additional water to an extent that would eliminate their shortages in dry years. Since this supplemental pumpage would be outside of and not a part of regular project operations, neither the additional costs that might be imposed or the possible benefits that might accrue, nor the decreased water supply shortage that would result, have been estimated under the project operations analysis.

In order to assure a dependable water supply for the project lands served by the Silt pumping plant and canal, project plans recommend the reservation of an estimated maximum of 6,600 acre-feet of storage water in Green Mountain Reservoir on the Colorado River.





A comparison of the adequacy of project water supplies by months and evaluation areas is given in table 6.

Table 6. - Average water supply, percent of requirements, by months and evaluation areas, Silt project <sup>1/</sup>

| : Projected Water Supply With Project       |               |               | : Historical Water Supply Without Project <sup>2/</sup> |               |                     |
|---|---------------|---------------|---|---------------|---------------------|
| : Harvey Mesa : Davie Mesa : Dry Elk Valley |               |               | : Harvey Mesa : Dry Elk Valley                          |               |                     |
| Month                                       | : Evaluation  | : Evaluation  | : Evaluation  | : Evaluation  | : Evaluation        |
|   | : Areas A & B | : Areas C & D | : Areas E, F, G & H                                     | : Areas A & B | : Areas E, F, G & H |
| - - - - - Percent - - - - -                 |               |               |   |               |                     |
| May   | 100           | 100           | 100   | 100           | 73                  |
| June  | 100           | 100           | 100   | 98            | 31                  |
| July  | 100           | 100           | 100   | 56            | 17                  |
| Aug.  | 90            | 84            | 90  | 35            | 25                  |
| Sept.                                       | 73            | 81            | 79  | 43            | 54                  |
| Oct.  | 100           | 100           | 75  | 100           | 54                  |

<sup>1/</sup> Based on 24-year study period 1937-1960 inclusive.

<sup>2/</sup> Davie Mesa, evaluation areas C and D, not irrigated under without-project conditions.

Under project operations, all lands will have a full water supply except in years of unusually deficient water yield. Effective operation of the Silt pumping plant will greatly reduce the effect of local minor water yield deficiencies. Occasional years of extremely deficient water supply, such as have occurred in the past, will result in some water supply shortages for project lands. A comparison of historical water supplies and those that would be available with the project, based on data provided by the Bureau of Reclamation, is given in table 7. Anticipated water shortages are reflected in crop yield estimates of project lands.

Interspersed among the project lands is a limited acreage of non-project land with rights to a proportional share of the present water supply. These lands are generally too steep for effective cultivation or have profile or other limitations which make them undesirable for inclusion within the project. They will continue to receive the normal water supply to which they are legally entitled from appropriate sources of supply, depending upon their location, but the supply will not be supplemented from



Table 7. - Comparison of annual water supply with and without project, by evaluation areas, Silt project <sup>1/</sup>

| Percent<br>of Water<br>Requirements<br>Available | Percent of Years the "Percent of Water Requirements Available"<br>was Equalled or Exceeded |         |                        |         |                  |         |
|--|--|---------|------------------------|---------|------------------|---------|
|  | Harvey Mesa  |         | Davie Mesa             |         | Dry Elk Valley   |         |
|  | Evaluation Areas A & B   |         | Evaluation Areas C & D |         | Evaluation Areas |         |
|  | E, F, G & H  |         |                        |         |                  |         |
|  | With Project   | Without | With Project           | Without | With             | Without |
|  | Supply   | Project | Supply                 | Project | Project          | Project |
|  |  | Supply  |                        | Supply  | Supply           | Supply  |
|  | Percent  |         |                        |         |                  |         |
| 100  | 65   | 2       | 69                     | 69      | -                | -       |
| 90   | 75   | 17      | 78                     | 77      | -                | -       |
| 80   | 92   | 36      | 96                     | 96      | 0.1              | 0.1     |
| 70   | 99+  | 45      | 99+                    | 99+     | 0.9              | 0.9     |
| 60   | -  | 52      | -                      | -       | 5.0              | 5.0     |
| 50   | -  | 90      | -                      | -       | 17.0             | 17.0    |
| 40   | -  | 99      | -                      | -       | 39.0             | 39.0    |

<sup>1/</sup> Based on 24-year study period 1937-1960 inclusive.

project sources. There are 112 acres of these lands located in the Dry Elk Valley and 358 acres on Harvey Mesa. They produce a limited amount of forage and are owned and managed in conjunction with the project lands with which they are intermingled.

Water from both Rifle Creek and the Colorado River has been analyzed and found suitable for irrigation of project lands.

### Findings

Based on estimates of consumptive use requirements and irrigation efficiencies, an average 2.86 acre-feet of water per irrigable acre will be required at the farm headgates to adequately serve the project lands. Reservoir and project operations studies and records of historical flows indicate that the water supplies available from project facilities will be adequate to meet this requirement in all but exceptionally dry years. The average water supply available for delivery to farmers during a period of years comparable to the 1937-1960 study period would be 96 percent of estimated requirements. The project water requirements and water supply are summarized in table 8.





Table 8. -- Projected crop distribution and seasonal consumptive use and water requirement estimates by evaluation areas, Silt project

| Harvey and Davie Mesas |                |                |      |            |   |             |  |                |  | Dry Elk Valley |                |     |             |  |           |  |  |  |  |
|------------------------|----------------|----------------|------|------------|---|-------------|--|----------------|--|----------------|----------------|-----|-------------|--|-----------|--|--|--|--|
| Evaluation:<br>area    | Crop           | Net            |      | Projected  |   | Net water   |  | Irrigation     |  | Crop           | Net            |     | Projected   |  | Net water |  |  |  |  |
|                        |                | : requirement: |      | : net crop |   | : supply    |  | : requirement: |  |                | : requirement: |     | : supply    |  |           |  |  |  |  |
|                        |                | : Acres        |      | : Acres    |   | : Acre-feet |  | : Acres        |  |                | : Acres        |     | : Acre-feet |  |           |  |  |  |  |
|                        |                | : Inches       |      |            |   |             |  | : Inches       |  |                |                |     | : Inches    |  |           |  |  |  |  |
| A                      | Alfalfa        | 23.03          | 1253 |            | E | 2404.7      |  |                |  | Alfalfa        | 20.92          | 107 |             |  | 186.5     |  |  |  |  |
|                        | Clover & Grass |                |      |            |   |             |  |                |  | Clover & Grass |                |     |             |  |           |  |  |  |  |
|                        | Pasture        | 21.34          | 633  |            |   | 1125.7      |  |                |  | Pasture        | 19.30          | 15  |             |  | 24.1      |  |  |  |  |
|                        | Corn           | 16.45          | 270  |            |   | 370.1       |  |                |  | Corn           | 14.45          | 24  |             |  | 28.9      |  |  |  |  |
|                        | Small Grain    | 13.13          | 492  |            |   | 538.3       |  |                |  | Small Grain    | 12.25          | 24  |             |  | 24.5      |  |  |  |  |
| B                      | Beets          | 16.08          | 375  |            |   | 502.5       |  |                |  |                |                |     |             |  |           |  |  |  |  |
|                        | Alfalfa        | 23.03          | 658  |            | F | 1262.8      |  |                |  | Alfalfa        | 20.92          | 108 |             |  | 188.3     |  |  |  |  |
|                        | Clover & Grass |                |      |            |   |             |  |                |  | Clover & Grass |                |     |             |  |           |  |  |  |  |
|                        | Pasture        | 21.34          | 326  |            |   | 579.7       |  |                |  | Pasture        | 19.30          | 12  |             |  | 19.3      |  |  |  |  |
|                        | Small Grain    | 13.13          | 390  |            |   | 426.7       |  |                |  | Small Grain    | 12.25          | 47  |             |  | 48.0      |  |  |  |  |
| C                      | Alfalfa        | 23.03          | 148  |            | G | 284.0       |  |                |  | Alfalfa        | 20.92          | 123 |             |  | 214.4     |  |  |  |  |
|                        | Clover & Grass |                |      |            |   |             |  |                |  | Clover & Grass |                |     |             |  |           |  |  |  |  |
|                        | Pasture        | 21.34          | 241  |            |   | 428.6       |  |                |  | Pasture        | 19.30          | 72  |             |  | 115.8     |  |  |  |  |
|                        | Corn           | 16.45          | 77   |            |   | 105.6       |  |                |  | Corn           | 14.45          | 19  |             |  | 22.9      |  |  |  |  |
|                        | Small Grain    | 13.13          | 77   |            |   | 84.3        |  |                |  | Small Grain    | 12.25          | 57  |             |  | 58.2      |  |  |  |  |
| D                      | Beets          | 16.08          | 75   |            |   | 100.5       |  |                |  | Beets          | 13.64          | 50  |             |  | 56.8      |  |  |  |  |
|                        | Alfalfa        | 23.03          | 60   |            | H | 115.1       |  |                |  | Alfalfa        | 20.92          | 88  |             |  | 153.4     |  |  |  |  |
|                        | Clover & Grass |                |      |            |   |             |  |                |  | Clover & Grass |                |     |             |  |           |  |  |  |  |
|                        | Pasture        | 21.34          | 85   |            |   | 151.2       |  |                |  | Pasture        | 19.30          | 144 |             |  | 231.6     |  |  |  |  |
|                        | Small Grain    | 13.13          | 58   |            |   | 63.5        |  |                |  | Small Grain    | 12.25          | 93  |             |  | 94.9      |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | Dry Elk Valley |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | Harvey Mesa    |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | Davie Mesa     |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | Areas A & B    |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | Areas C & D    |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | E, F, G & H    |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | Project Total  |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 10,011         |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 8,851          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 18,862         |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 6,597          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.86           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.74           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 96             |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 94             |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.71           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.83           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 872            |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2,464          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,131          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,468          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,333          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 7,210          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 6,405          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 13,615         |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 4,680          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.91           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.74           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 94             |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.71           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.83           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 872            |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2,464          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,131          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,468          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,333          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 7,210          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 6,405          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 13,615         |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 4,680          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.91           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.74           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 94             |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.71           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.83           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 872            |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2,464          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,131          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,468          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,333          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 7,210          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 6,405          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 13,615         |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 4,680          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.91           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.74           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 94             |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.71           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.83           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 872            |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2,464          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,131          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,468          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,333          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 7,210          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 6,405          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 13,615         |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 4,680          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.91           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.74           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 94             |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.71           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.83           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 872            |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2,464          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,131          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,468          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,333          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 7,210          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 6,405          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 13,615         |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 4,680          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.91           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.74           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 94             |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.71           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.83           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 872            |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2,464          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,131          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,468          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,333          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 7,210          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 6,405          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 13,615         |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 4,680          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.91           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.74           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 94             |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.71           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.83           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 872            |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2,464          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,131          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,468          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,333          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 7,210          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 6,405          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 13,615         |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 4,680          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.91           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.74           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 94             |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.71           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.83           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 872            |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2,464          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,131          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,468          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,333          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 7,210          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 6,405          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 13,615         |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 4,680          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.91           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.74           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 94             |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.71           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.83           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 872            |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2,464          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,131          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,468          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,333          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 7,210          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 6,405          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 13,615         |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 4,680          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.91           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.74           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 94             |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.71           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.83           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 872            |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2,464          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,131          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,468          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,333          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 7,210          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 6,405          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 13,615         |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 4,680          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.91           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.74           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 94             |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.71           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.83           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 872            |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2,464          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,131          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,468          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,333          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 7,210          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 6,405          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 13,615         |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 4,680          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.91           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.74           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 94             |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.71           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.83           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 872            |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2,464          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,131          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,468          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,333          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 7,210          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 6,405          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 13,615         |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 4,680          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.91           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.74           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 94             |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.71           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.83           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 872            |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2,464          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,131          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,468          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,333          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 7,210          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 6,405          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 13,615         |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 4,680          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.91           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.74           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 94             |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.71           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.83           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 872            |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2,464          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,131          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,468          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,333          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 7,210          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 6,405          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 13,615         |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 4,680          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.91           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.74           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 94             |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.71           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.83           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 872            |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2,464          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,131          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,468          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,333          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 7,210          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 6,405          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 13,615         |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 4,680          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.91           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.74           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 94             |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.71           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.83           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 872            |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2,464          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,131          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,468          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,333          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 7,210          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 6,405          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 13,615         |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 4,680          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.91           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.74           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 94             |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.71           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.83           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 872            |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2,464          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,131          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,468          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,333          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 7,210          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 6,405          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 13,615         |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 4,680          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.91           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.74           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 94             |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.71           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.83           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 872            |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2,464          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,131          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,468          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,333          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 7,210          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 6,405          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 13,615         |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 4,680          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.91           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.74           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 94             |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.71           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.83           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 872            |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2,464          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,131          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,468          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,333          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 7,210          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 6,405          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 13,615         |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 4,680          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.91           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.74           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 94             |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.71           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.83           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 872            |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2,464          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,131          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,468          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,333          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 7,210          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 6,405          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 13,615         |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 4,680          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.91           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.74           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 94             |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.71           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.83           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 872            |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2,464          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,131          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,468          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,333          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 7,210          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 6,405          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 13,615         |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 4,680          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.91           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.74           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 94             |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.71           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.83           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 872            |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2,464          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,131          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,468          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,333          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 7,210          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 6,405          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 13,615         |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 4,680          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.91           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.74           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 94             |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.71           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.83           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 872            |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2,464          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,131          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,468          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,333          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 7,210          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 6,405          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 13,615         |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 4,680          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.91           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.74           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 94             |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.71           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.83           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 872            |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2,464          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,131          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,468          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,333          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 7,210          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 6,405          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 13,615         |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 4,680          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.91           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.74           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 94             |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.71           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.83           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 872            |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2,464          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,131          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,468          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,333          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 7,210          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 6,405          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 13,615         |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 4,680          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.91           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.74           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 94             |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.71           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.83           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 872            |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2,464          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,131          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,468          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,333          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 7,210          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 6,405          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 13,615         |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 4,680          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.91           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.74           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 94             |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.71           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.83           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 872            |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2,464          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,131          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,468          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 1,333          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 7,210          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 6,405          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 13,615         |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 4,680          |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.91           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.74           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 94             |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  | 2.71           |                |     |             |  |           |  |  |  |  |
|                        |                |                |      |            |   |             |  |                |  |                |                |     |             |  |           |  |  |  |  |





## Land and Irrigation Development

### Sources of Data

The soil survey has been generally interpreted in terms of land use and treatment as provided in the Technical Guide of the Bookcliff Soil Conservation District and the Irrigation Guide for Western Colorado Areas Below 7,000 Feet. Land classification surveys of the Bureau of Reclamation furnished supplemental information. Special site investigations, infiltration measurements, and other surveys, and direct inspection of field conditions and review with technicians familiar with the area, have furnished additional basic data. Farm plans and records of land leveling and farm irrigation development work accomplished with the assistance of Soil Conservation Service technicians assigned to the Bookcliff Soil Conservation District, have been used to obtain basic estimates of unit volumes and costs.

Development requirements have been related to the physical characteristics of the various soil mapping units on the project. Projected land development, as influenced by the soil and site characteristics, has been estimated by each capability unit and averaged by evaluation areas. Interspersed lands not included in the project have been excluded from the report. Cost estimates are based on the U. S. Department of Agriculture price projections of September 1957.

### Farm Irrigation Development

Irrigation water supplies for the project area have been inadequate for the presently cultivated lands; hence, there has been no significant development of new lands in recent years. However, there has been a limited amount of additional development work accomplished since the original subjugation of the present farms. Most of this has been in connection with the stabilization of the present irrigation and has usually been restricted to: lands with better water rights; situations where specific opportunities existed for improving irrigation efficiencies and the effectiveness of the present water supply; or the improvement of particular problem areas where conditions resulted in unusual difficulty in obtaining satisfactory irrigation. In general, the principal improvements have consisted of adjustment of lengths of run to more nearly fit the requirement of the specific sites affected, the installation of limited drainage facilities, or to the leveling of uneven or undulating fields.

Under present water supply conditions, there has been little economic incentive for development of the land at a rate faster than has occurred. It is expected, therefore, that in the future without the project, conditions would remain little changed from the present and that additional land development would be largely restricted to the correction of specific problems of limited extent. With project development, the increased water supply and resulting better yields and improved economy will provide a basis for increased development. Complete irrigation systems and related development will be required for the projected new lands, and continued improvement in accordance with their site requirements can reasonably be expected for the presently cultivated lands and facilities.





There are only limited areas of soils within the project having stony surfaces or profiles. These are all in capability class IV and limited to pasture and close growing crops. The estimated cost of rock and stone removal and the inherent limitations indicated by the capability classification indicate that these lands would be best restricted to hay and pasture use, for which no clearing would be required. Accordingly, no rock or stone removal has been estimated as an item of land development cost.

There are only limited data on which to base an estimate of the amount of increase in land and irrigation development that can be expected on the presently cultivated lands under the changed conditions assumed with project development. An approach has been made by estimating the requirements in accordance with the actual requirements for various capability units within or near the project area and interpolation of the remaining capability units at appropriate levels. A discounting factor based on estimates by local technicians of the requirements of the area and the cropping patterns and site factors, has been incorporated into the development estimates. Based on this procedure, estimates of average land development associated with project construction have been made and projected to the various evaluation areas. These are summarized in table 9.

#### Farm Drainage Development

There are considerable areas of wet or potentially wet lands within the project. Project plans include estimates for project drainage installations to provide drainage and drainage outlets for these lands. No on-farm drainage installations are included in the project drainage plans.

Detailed plans and cost estimates for on-farm drainage are not practical until observations are available of the behavior of the affected areas after the installation of the planned project drainage and an analysis of the relative economics of each site in the light of the soil capability and proposed usage. However, tentative estimates have been made of the extent of on-farm drainage installations and of the probable capital and annual costs assumed to result therefrom. The economic benefit studies assume the levels and costs of land, irrigation and drainage development outlined.

Cost estimates for on-farm drainage requirements have been made on the basis of soil types and site characteristics, with due regard to the probability that soils in certain capability units will be most economically used by retaining them in wet pasture condition. Permeability data has been furnished by the Bureau of Reclamation. Drainage requirements for specific areas have been based on the application of the Donnan procedure, and costs have been estimated by the extension of resulting typical unit costs to the areas mapped.

#### Findings

Estimates of development costs for project lands are based on an analysis of the physical requirements of the soils and site conditions. They are related to projected economic conditions and to the minimum requirements





Table 9. - Summary of land and irrigation development and farm drainage, by evaluation areas,  
Silt project

| Item  | Unit  | Evaluation Areas |       |       |       |       |      |       |      |
|---|---|------------------|-------|-------|-------|-------|------|-------|------|
|   |   | A                | B     | C     | D     | E     | F    | G     | H    |
| Irrigable land                                    | Acres   | 3,218            | 1,462 | 657   | 215   | 181   | 177  | 341   | 346  |
| Dominant slopes                                   | Percent   | 1-6              | 6-12  | 1-3   | 6-12  | 3-6   | 6-12 | 3-6   | 6-12 |
| Dominant profile depth                            | Feet  | 5                | 5     | 5     | 5     | 5     | 5    | 5     | 5    |
| Dominant irrigation methods                       | Predominantly corrugation for close growing crops, furrow for row crops |                  |       |       |       |       |      |       |      |
| Maximum furrow stream size                        | GPM   | 12               | 4     | 10    | 2     | 10    | 5    | 10    | 5    |
| Average farm irrigation efficiency                | Percent   | 55               | 49    | 56    | 49    | 55    | 50   | 55    | 51   |
| Peak period consumptive use rate                  | Ins./Day  | .20              | .20   | .20   | .20   | .20   | .20  | .20   | .20  |
| Average maximum length of runs                    | Feet  | 340              | 225   | 370   | 200   | 340   | 260  | 340   | 240  |
| Average field ditch and lateral required          | Ft./Acre  | 140              | 201   | 139   | 227   | 136   | 176  | 139   | 198  |
| Weighted average land leveling earthwork required | Cy./Ac.   | 200              | 84    | 176   | 130   | 138   | 101  | 221   | 100  |
| Farm irrigation structure, average cost per acre  | Dollars   | 10.85            | 4.18  | 26.24 | 16.55 | 10.85 | 4.18 | 19.11 | 4.18 |
| Weighted average farm drainage, cost per acre     | Dollars   | 12.16            | 1.53  | -     | -     | -     | -    | -     | -    |





for land and water management at the levels expected under project conditions. Weighted average development cost estimates are summarized by evaluation areas in table 10.

Table 10. - Cost of land and irrigation development by evaluation areas,  
Silt project

| Evaluation Area | Cost Per Acre |          |            |          |       |
|-----------------|---------------|----------|------------|----------|-------|
|                 | Clearing      | Leveling | Farm       | Drainage | Total |
|                 |               |          | Irrigation |          |       |
|                 |               |          | System     |          |       |
| <u>Dollars</u>  |               |          |            |          |       |
| A               | 1.20          | 36.24    | 15.43      | 12.16    | 65.03 |
| B               | 0.90          | 15.05    | 8.59       | 1.53     | 26.07 |
| C               | -             | 31.70    | 34.83      | -        | 66.53 |
| D               | -             | 23.44    | 28.93      | -        | 52.37 |
| E               | -             | 24.86    | 14.18      | -        | 39.04 |
| F               | -             | 18.15    | 8.75       | -        | 26.90 |
| G               | 2.63          | 39.82    | 27.32      | -        | 69.77 |
| H               | 4.56          | 18.00    | 15.36      | -        | 37.92 |



## Projected Agricultural Economy

Economic analysis of the proposed Silt irrigation project has two primary objectives: (1) An appraisal of direct agricultural benefits from project development; and (2) an appraisal of prospective farm incomes from representative sizes and types of farms considered most likely with proposed irrigation development. Both analyses will contribute to a general appraisal of the prospects for a successful and stable irrigated agricultural economy.

### Procedures

An estimate of agricultural benefits and an appraisal of prospective farm incomes were derived by farm-budgeting procedures. Crop-production budgets were used in analyzing agricultural benefits; they were limited to costs and returns of crop and pasture production that would exist with a livestock economy. Farm-income budgets were used in analyzing prospective farm incomes by type of farm. In this analysis, costs and returns were carried through the livestock enterprises. The farm acreages, cropping systems, and crop yields established for appraisal of farm incomes were also used in budgeting for agricultural benefits.

The crop-production budgets consist of three basic elements: (1) The estimated quantity and value of crop and pasture production without and with project after full development of the farms; (2) the quantity and value of economic resources used in achieving the assumed level of production without and with project development (exclusive of water costs); and (3) the delay involved in achieving the increased level of production, which is accounted for by discounting procedures.

Farm-income budgets, representing costs and returns of all the enterprises anticipated for given farm types, used in estimating residual farm incomes. These incomes are available as compensation to farm operators and their families for their labor and management and for payment of water charges. The major elements involved in the analysis were: (1) The quantity of agricultural products produced for sale and their expected market values; (2) the quantity and value of resource inputs expended by project farmers to achieve the level of production anticipated (exclusive of water costs); and (3) allowance for the labor and management of the operator and family equivalent to estimated incomes that would be derived from alternative employment.

### Source of Data

Numerous economic studies on irrigation development were relied upon for the economic and physical standards and the procedures used in these analyses. This background information was supplemented by specific information for the Silt project obtained from four major sources: (1) An economic survey of farms in the project area conducted during 1958 in cooperation with the Bureau of Reclamation; (2) material furnished by the Bureau of Reclamation; (3) economic analyses of other projects; <sup>1/</sup> and (4) information furnished by Colorado State University personnel, local representatives of Federal and State agencies, irrigation companies, county officials and businessmen.

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<sup>1/</sup> Reappraisal by the USDA of Direct Agricultural Benefits for the Vernal Unit, Central Utah Project, and Paonia, Hammond, Smith Fork, Seedskadee, Florida, and Emery County projects, Upper Colorado River Storage Project





## Commodity Price Projections

All prices used in estimating farm incomes, direct benefits, and associated costs are based on the September 1957 price projections of the U. S. Department of Agriculture. These projections assume "relatively high employment, a trend toward peace, continued population and economic growth, and a stable general price level."

The long-term projected index of prices received for all farm commodities is 235, base period 1910-14. A comparable index for prices paid, including interest, wages, and taxes is 265.

The price of rotation pasture used in the benefit analysis is derived from the long-term projected price of alfalfa. The computed price is based on the net income derived from alfalfa, adjusted for differences in costs of production and per acre yield of total digestible nutrients. The derived price results in the same net return per acre for alfalfa hay and rotation pasture.

Information obtained during the field survey showed that, historically, prices received locally for specific agricultural commodities marketed have been about the same as the State average prices. Projected prices for livestock and livestock products are based on data collected from the Denver and Grand Junction markets. All prices were adjusted for marketing costs and are net prices to farmers. Projected prices of crops, livestock, livestock products, and selected cost items for the Silt project are shown in table 11.

## Farm Sizes

Irrigated acreage was 89 acres per farm on all farms surveyed and 121 acres on full-time farms. The economic survey included a sample of 24 full-time and 20 part-time farms.

Projected farm sizes for both with and without project are based on a family-size-farm concept in which the operator and his family furnish all the labor except during the crop harvesting season. Present sizes, current trends in size of farms, legal limitations of 160 acres of irrigable land per ownership, prospective farm incomes, and other factors were considered in establishing projected farm sizes.

## Anticipated Crop Yields

Projected crop yields estimated for evaluation areas, without and with project development, are shown in tables 12 and 13. Production estimates are based on crop yields obtained in comparable areas, estimates by farmers in the project area and agricultural technicians familiar with the area, and other pertinent crop yield data. Yields reflect estimates of average managerial skill for farmers on the project.





Table 11.- Long-term projected prices received and selected prices paid,  
Silt project

| Item  | Unit            | Price<br><u>Dollars</u> |
|---|-----------------|-------------------------|
| <u>Prices received 1/</u>                         |                 |                         |
| Alfalfa hay, baled 2/                             | Ton             | 20.60                   |
| Corn silage 3/                                    | do              | 7.35                    |
| Barley  | Bushel          | 1.05                    |
| Sugar beets                                       | Ton             | 14.40                   |
| Straw   | do              | 10.00                   |
| Butterfat (whole milk) 4/                         | Pound butterfat | 1.06                    |
| Grade A   | do              | 1.16                    |
| Grade C   | do              | .79                     |
| Cows (dairy)                                      | Cwt.            | 12.30                   |
| Calves (day old dairy bulls)                      | Head            | 10.00                   |
| Calves (day old dairy heifers)                    | do              | 20.00                   |
| Cows (beef)                                       | Cwt.            | 14.30                   |
| Calves (beef steers)                              | do              | 21.40                   |
| Calves (beef heifers)                             | do              | 19.10                   |
| Long yearlings (beef steers)                      | do              | 19.80                   |
| Long yearlings (beef heifers)                     | do              | 17.40                   |
| Cull ewes   | Cwt.            | 6.30                    |
| Lambs   | do              | 21.75                   |
| Wool  | Pound           | .49                     |
| <u>Prices paid</u>                                |                 |                         |
| Hired labor                                       | Hour            | 1.00                    |
| Custom rages:                                     |                 |                         |
| Baling hay  | Ton             | 5.00                    |
| Combining   | Acre            | 5.50                    |
| Chopping corn                                     | do              | 16.00                   |
| Thinning beets                                    | do              | 17.50                   |
| Hoeing beets (2 times)                            | do              | 13.00                   |
| Pulling, topping, and loading<br>beets by machine | Ton             | 1.50                    |
| Hauling beets to dump                             | do              | 1.00                    |

1/ Net price received by farmers.

2/ Price in stack after shrinkage.

3/ Based on the price of alfalfa; 2.8 tons of corn silage equivalent to 1 ton of alfalfa.

4/ Weighted average includes 73 percent grade A and 27 grade C at 3.5 test.

Based on price projections by the U. S. Department of Agriculture,  
September 1957.



Table 12.- Projected crop yields, without project development, by evaluation areas, Silt project

| Crop                | Unit | Evaluation area |       |       |       |
|---------------------|------|-----------------|-------|-------|-------|
|                     |      | A               | B     | E     | F     |
| Alfalfa 1/          | Ton  | 3.0             | 2.8   | 1.7   | 1.5   |
| Rotation pasture 1/ | AUM  | 6.0             | 5.6   | 3.4   | 3.0   |
| Corn silage 1/      | Ton  | 11.5            | ----- | ----- | ----- |
| Barley              | Bu.  | 60.0            | 55.0  | 50.0  | 45.0  |
| Sugar beets 1/      | Ton  | 13.5            | ----- | ----- | ----- |
| Permanent pasture   | AUM  | 3.0             | 3.0   | 2.0   | 2.0   |

1/ Fertilizer: Annual requirement (available) per unit of yield; alfalfa, 7.5 pounds phosphate per ton; rotation pasture, 3 pounds of phosphate and 6 pounds of nitrogen per AUM; corn silage, 5 pounds nitrogen per ton; sugar beets, 4.5 pounds phosphate and 5.5 pounds nitrogen per ton. Total phosphate required applied at time of seeding, nitrogen applied to pasture once each year.

Table 13.- Projected crop yields, with project development, by evaluation areas, Silt project

| Crop                | Unit | Evaluation area |       |       |       |       |       |       |       |
|---------------------|------|-----------------|-------|-------|-------|-------|-------|-------|-------|
|                     |      | A               | B     | C     | D     | E     | F     | G     | H     |
| Alfalfa 1/          | Ton  | 4.0             | 3.5   | 4.0   | 3.5   | 3.7   | 3.2   | 3.7   | 3.2   |
| Rotation pasture 1/ | AUM  | 8.0             | 7.0   | 8.0   | 7.0   | 7.4   | 6.4   | 7.4   | 6.4   |
| Corn silage 1/      | Ton  | 15.0            | ----- | 15.0  | ----- | 15.0  | ----- | 15.0  | ----- |
| Barley              | Bu.  | 70.0            | 60.0  | 70.0  | 60.0  | 70.0  | 60.0  | 70.0  | 60.0  |
| Sugar beets 1/      | Ton  | 16.0            | ----- | 16.0  | ----- | ----- | ----- | 16.0  | ----- |
| Permanent pasture   | AUM  | 3.0             | 3.0   | ----- | ----- | 2.0   | 2.0   | ----- | ----- |

1/ Fertilizer: Annual requirement (available) per unit of yield; alfalfa, 7.5 pounds phosphate per ton; rotation pasture, 3 pounds of phosphate and 6 pounds of nitrogen per AUM; corn silage, 5 pounds nitrogen per ton; sugar beets, 4.5 pounds phosphate and 5.5 pounds nitrogen per ton. Total phosphate required applied at time of seeding, nitrogen applied to pasture twice each year.





## Anticipated Cropping Systems

Climate, topography, distance to central markets, and opportunities for off-farm employment influence the kinds of crops that are commercially produced in the project area. Present irrigated crops consist of alfalfa and pasture on 74 percent of the cropland; small grains on 19 percent; corn silage on 4.5 percent; and sugar beets and potatoes on 2.5 percent. Development of the project is not expected to affect the kinds of crops produced.

Development of the project is expected to increase the percentage of the project area in rotation pasture, corn silage, and sugar beets and to decrease the percentage in alfalfa and small grains (table 14). On farms that do not grow sugar beets, a 7-year crop rotation is assumed, including 5 years of alfalfa or rotation pasture, and 2 years of grain and corn for silage or if topography was a limiting factor grain was substituted for corn silage in the rotation. A 9-year crop rotation was assumed on farms on which sugar beets were grown. Small grain was used as a nurse crop in the seeding of alfalfa and rotation pasture.

A 9-year crop rotation was assumed on evaluation areas A, C, and G. On evaluation areas B, D, E, F, and H a 7-year rotation was projected. Because of slopes, corn silage and sugar beets were not projected on evaluation areas B, D, F, and H.

Table 14.- Projected cropping pattern, without and with project development, by evaluation areas, Silt project

| Crop                   | Evaluation areas |       |       |       |       |       |       |       |       | Project |
|------------------------|------------------|-------|-------|-------|-------|-------|-------|-------|-------|---------|
|                        | A                | B     | C     | D     | E     | F     | G     | H     |       |         |
|                        | Acres            | Acres | Acres | Acres | Acres | Acres | Acres | Acres | Acres |         |
| <u>Without Project</u> |                  |       |       |       |       |       |       |       |       |         |
| Alfalfa                | 1,214            | 597   | ----- | ----- | 122   | 120   | ----- | ----- | 2,053 |         |
| Rotation pasture       | 556              | 260   | ----- | ----- | ----- | ----- | ----- | ----- | 816   |         |
| Corn silage            | 247              | ----- | ----- | ----- | ----- | ----- | ----- | ----- | 247   |         |
| Barley                 | 469              | 341   | ----- | ----- | 48    | 47    | ----- | ----- | 905   |         |
| Sugar beets            | 150              | ----- | ----- | ----- | ----- | ----- | ----- | ----- | 150   |         |
| Range, nonirrigated    | 387              | 176   | 657   | 215   | ----- | ----- | 341   | 346   | 2,122 |         |
| Farmstead, etc.        | 195              | 88    | ----- | ----- | 11    | 10    | ----- | ----- | 304   |         |
| Total                  | 3,218            | 1,462 | 657   | 215   | 181   | 177   | 341   | 346   | 6,597 |         |
| Permanent pasture 1/   | 255              | 110   | ----- | ----- | 56    | 54    | ----- | ----- | 475   |         |
| <u>With Project</u>    |                  |       |       |       |       |       |       |       |       |         |
| Alfalfa                | 1,253            | 658   | 148   | 60    | 107   | 108   | 123   | 88    | 2,545 |         |
| Rotation pasture       | 633              | 326   | 241   | 85    | 15    | 12    | 72    | 144   | 1,528 |         |
| Corn silage            | 270              | ----- | 77    | ----- | 24    | ----- | 19    | ----- | 390   |         |
| Barley                 | 492              | 390   | 77    | 58    | 24    | 47    | 57    | 93    | 1,238 |         |
| Sugar beets            | 375              | ----- | 75    | ----- | ----- | ----- | 50    | ----- | 500   |         |
| Farmstead, etc.        | 195              | 88    | 39    | 12    | 11    | 10    | 20    | 21    | 396   |         |
| Total                  | 3,218            | 1,462 | 657   | 215   | 181   | 177   | 341   | 346   | 6,597 |         |
| Permanent pasture 1/   | 255              | 110   | ----- | ----- | 56    | 54    | ----- | ----- | 475   |         |

1/ Nonproject lands projected to receive essentially the same supply of water without and with project development.





## Direct Agricultural Benefits

A primary objective of the economic analysis is to estimate direct agricultural benefits. These benefits are defined as the value of crop and pasture production expected with project development over the value anticipated without the project, minus the value of additional farm inputs or associated costs required. The concepts and assumptions on the specific composition and value of nonproject resources or associated costs, as used in this report, are outlined below.

A basic assumption is that the national economy will operate at essentially full employment for the period of analysis. With this general assumption, alternative employment opportunities would be expected in the national economy for resources used in the development and operation of irrigated farms, including the labor and management skills of farm operators. Also, the projected levels of farm prices received and paid are higher than they would be with significant unemployment.

Estimates of direct agricultural benefits are based on crop-production budgets that account for the quantity and value of crop and pasture production expected after full development of project farms, and for the cost that will be incurred on the project lands in achieving the level of production expected. Estimates were made for each evaluation area and for the project area as a whole.

The cropping patterns assumed in the benefit analysis are the same as those used in the analysis of water requirements and prospective farm incomes.

Farms with adequate water supplies will require considerably more labor than farms with partial supplies. The additional operator and family labor required is considered as an economic cost in deriving benefits attributable to the project.

### Labor and Management Charges

Labor for crop production on project lands will be required during the summer. Thus, the summer hired wage rate assumed in the analysis (\$1.00 per hour) was applied to operator and family labor in evaluating direct agricultural benefits from irrigation water. A management allowance or charge was made for the farm operators also. This amounts to 15 percent of the hired wage rate. Based on these rates and an allocation of 75 percent of the hours to the operator and 25 percent to the family, the hourly rate would be \$1.11.

### Return to Land and Water

Summaries of the average value of crop production, annual production costs, and return to operator and family labor and management, land and water, without and with project development, are shown by evaluation areas in tables 15 and 16. Net income, cost of operator and family labor and management, and the weighted average increase in net income with project development by evaluation areas are shown in table 17. Deduction of all expenses and allowances except those for land and water leaves a weighted average net return to these resources ranging from \$34.71 per acre for evaluation area G to \$9.67 per acre for evaluation area B.



Table 15.- Net income from crop production to operator and family labor and management, land, and water, without project development, by evaluation areas, Silt project

| Item                          | Unit   | Evaluation areas |       |       |       |
|-------------------------------|--------|------------------|-------|-------|-------|
|                               |        | A                | B     | E     | F     |
| Total land                    | Acre   | 130.0            | 150.0 | 135.0 | 155.0 |
| Alfalfa                       | do     | 48.8             | 61.3  | 91.0  | 105.0 |
| Rotation pasture              | do     | 22.4             | 26.7  | ----- | ----- |
| Corn silage                   | do     | 9.9              | ----- | ----- | ----- |
| Barley                        | do     | 18.9             | 35.0  | 36.0  | 41.0  |
| Sugar beets                   | do     | 6.0              | ----- | ----- | ----- |
| Idle                          | do     | 16.0             | 18.0  | ----- | ----- |
| Farmstead, etc.               | do     | 8.0              | 9.0   | 8.0   | 9.0   |
| Operator and family labor     | Hour   | 1,158            | 1,396 | 1,058 | 1,236 |
| Investment                    | Dollar | 9,224            | 8,905 | 8,776 | 8,880 |
| Buildings and improvement     | do     | 1,455            | 1,435 | 1,386 | 1,451 |
| Machinery and equipment       | do     | 6,718            | 6,440 | 6,440 | 6,440 |
| Other                         | do     | 1,051            | 1,030 | 950   | 989   |
| Value of production           | do     | 7,392            | 6,898 | 5,265 | 5,414 |
| Production expenses <u>1/</u> | do     | 4,057            | 3,439 | 2,917 | 3,133 |
| Net crop income <u>2/</u>     | do     | 3,335            | 3,459 | 2,348 | 2,281 |
| Interest <u>3/</u>            | do     | 461              | 445   | 439   | 444   |
| Net income <u>4/</u>          | do     | 2,874            | 3,014 | 1,909 | 1,837 |

1/ Excluding interest, land and water development, and O&M.

2/ Return to operator and family labor and management, land and irrigation water.

3/ At 5 percent.

4/ Return to operator and family labor and management, land and irrigation water.

Based on price projections by the U. S. Department of Agriculture, September 1957.





Table 16.- Net income from crop production to operator and family labor and management, land, and water, with project development, by evaluation areas, Silt project

| Item                          | : Unit : | Evaluation area |       |        |       |        |       |        |       |
|-------------------------------|----------|-----------------|-------|--------|-------|--------|-------|--------|-------|
|                               |          | : A             | : B   | : C    | : D   | : E    | : F   | : G    | : H   |
| Total land                    | Acre     | 130.0           | 150.0 | 135.0  | 155.0 | 135.0  | 155.0 | 140.0  | 160.0 |
| Alfalfa                       | do       | 50.6            | 67.5  | 30.6   | 43.0  | 80.0   | 94.5  | 48.5   | 40.5  |
| Rotation pasture              | do       | 25.6            | 33.5  | 49.6   | 61.0  | 11.0   | 10.5  | 28.5   | 66.5  |
| Corn silage                   | do       | 10.9            | ----- | 15.9   | ----- | 18.0   | ----- | 7.5    | ----- |
| Barley                        | do       | 19.9            | 40.0  | 15.9   | 42.0  | 18.0   | 41.0  | 22.5   | 43.0  |
| Sugar beets                   | do       | 15.0            | ----- | 15.0   | ----- | -----  | ----- | 25.0   | ----- |
| Farmstead, etc.               | do       | 8.0             | 9.0   | 8.0    | 9.0   | 8.0    | 9.0   | 8.0    | 10.0  |
| Operator and family labor     | Hour     | 1,627           | 1,862 | 1,501  | 1,784 | 1,729  | 1,982 | 1,764  | 1,777 |
| Investment                    | Dollar   | 9,602           | 9,247 | 9,415  | 8,891 | 10,477 | 9,622 | 9,486  | 8,755 |
| Buildings and improvements    | do       | 1,475           | 1,435 | 1,532  | 1,451 | 1,557  | 1,451 | 1,474  | 1,467 |
| Machinery and equipment       | do       | 6,718           | 6,440 | 6,741  | 6,440 | 6,818  | 6,440 | 6,783  | 6,440 |
| Other                         | do       | 1,409           | 1,382 | 1,142  | 1,000 | 2,102  | 1,731 | 1,229  | 848   |
| Value of production           | do       | 11,988          | 9,430 | 12,248 | 9,458 | 9,890  | 9,411 | 13,729 | 9,070 |
| Production expenses <u>1/</u> | do       | 5,446           | 3,985 | 5,718  | 3,993 | 4,364  | 4,111 | 6,437  | 3,959 |
| Net crop income <u>2/</u>     | do       | 6,542           | 5,445 | 6,530  | 5,465 | 5,526  | 5,300 | 7,292  | 5,111 |
| Interest <u>3/</u>            | do       | 480             | 463   | 471    | 445   | 524    | 481   | 474    | 438   |
| Net income <u>4/</u>          | do       | 6,062           | 4,982 | 6,059  | 5,020 | 5,002  | 4,819 | 6,818  | 4,673 |

1/ Excluding interest, land and water development, and O&M.

2/ Return to operator and family labor and management, land and irrigation water.

3/ At 5 percent.

4/ Return to operator and family labor and management, land and irrigation water.

Based on price projections by the U. S. Department of Agriculture, September 1957.





Table 17.- Summary: Weighted average increase in net income, with project development, by evaluation areas, Silt project

| Item            | Net income 1/ | Operator & family labor | Cost of operator & family labor 2/ | Net income 2/ | Weighted Net income 3/ | Increased net income per acre |
|-----------------|---------------|-------------------------|------------------------------------|---------------|------------------------|-------------------------------|
| Evaluation area | Dollar        | Hours                   | Dollar                             | Dollar        | Acres                  | Dollar                        |
| A (with)        | 6,062         | 1,627                   | 1,806                              | 4,256         | 130                    | 32.74                         |
| A (without)     | 2,874         | 1,158                   | 1,285                              | 1,589         | 130                    | 12.22                         |
| B (with)        | 4,982         | 1,862                   | 2,067                              | 2,915         | 150                    | 19.43                         |
| B (without)     | 3,014         | 1,396                   | 1,550                              | 1,464         | 150                    | 9.76                          |
| C (with)        | 6,059         | 1,501                   | 1,666                              | 4,393         | 135                    | 32.54                         |
| D (with)        | 5,020         | 1,784                   | 1,980                              | 3,040         | 155                    | 19.61                         |
| E (with)        | 5,002         | 1,729                   | 1,919                              | 3,083         | 135                    | 22.84                         |
| E (without)     | 1,909         | 1,058                   | 1,174                              | 735           | 135                    | 5.44                          |
| F (with)        | 4,819         | 1,982                   | 2,200                              | 2,619         | 155                    | 16.90                         |
| F (without)     | 1,837         | 1,236                   | 1,372                              | 465           | 155                    | 3.00                          |
| G (with)        | 6,818         | 1,764                   | 1,958                              | 4,860         | 140                    | 34.71                         |
| H (with)        | 4,673         | 1,777                   | 1,972                              | 2,701         | 160                    | 16.88                         |

1/ Return to operator and family labor and management, land and water.

2/ At \$1.15 per hour for operator labor and management and \$1.00 per hour for family labor. Weighted average is based on 75 percent of hours by operator and 25 percent of hours by family.

3/ Net return to land and irrigation water.

Based on price projections by the U. S. Department of Agriculture, September 1957.



## Land Development Costs

The acreage of each evaluation area, the projected land values and the additional cost of land and farm irrigation systems, and annual cost per acre are shown in table 18. Costs of farm buildings, machinery, fences, domestic water, and maintenance and replacement costs of the farm irrigation system are included as farm expenses in the budgets. The degree of development anticipated on land and farm irrigation systems for each evaluation area was considered in setting up man and machine requirements.

Table 18.- Estimated average annual additional cost per acre of irrigable land for land and land development, with project development, by evaluation areas, Silt project

| Item                               | Unit   | Evaluation areas |        |       |       |        |        |       |       |
|------------------------------------|--------|------------------|--------|-------|-------|--------|--------|-------|-------|
|                                    |        | A                | B      | C     | D     | E      | F      | G     | H     |
| Land area 1/                       | Acre   | 3,005            | 1,356  | 657   | 215   | 181    | 177    | 341   | 346   |
| <u>Land values</u>                 |        |                  |        |       |       |        |        |       |       |
| Irrigated land                     | Dollar | 200.00           | 190.00 | ----- | ----- | 115.00 | 100.00 | ----- | ----- |
| Range, improved                    | do     | -----            | -----  | ----- | ----- | -----  | -----  | 25.00 | 25.00 |
| Range, unimproved                  | do     | 15.00            | 15.00  | 15.00 | 15.00 | -----  | -----  | 15.00 | 15.00 |
| Weighted average                   | do     | 177.98           | 168.93 | 15.00 | 15.00 | 115.00 | 100.00 | 23.36 | 23.82 |
| <u>Additional land improvement</u> |        |                  |        |       |       |        |        |       |       |
| Land                               | Dollar | 1.79             | 1.81   | 15.00 | 15.00 | -----  | -----  | 23.36 | 23.82 |
| Land clearing                      | do     | 1.20             | .90    | ----- | ----- | -----  | -----  | 2.63  | 4.56  |
| Land leveling                      | do     | 36.24            | 15.05  | 31.70 | 23.44 | 24.86  | 18.15  | 39.82 | 18.00 |
| Farm irrigation system             | do     | 15.43            | 8.59   | 34.83 | 28.93 | 14.18  | 8.75   | 27.32 | 15.36 |
| Drainage                           | do     | 12.16            | 1.53   | ----- | ----- | -----  | -----  | ----- | ----- |
| Total                              | do     | 66.82            | 27.88  | 81.53 | 67.37 | 39.04  | 26.90  | 93.13 | 61.74 |
| <u>Annual cost</u>                 |        |                  |        |       |       |        |        |       |       |
| Land 1/                            | Dollar | .09              | .09    | .76   | .76   | -----  | -----  | 1.18  | 1.20  |
| Land clearing 2/                   | do     | .06              | .05    | ----- | ----- | -----  | -----  | .13   | .23   |
| Land leveling 2/                   | do     | 1.83             | .76    | 1.60  | 1.18  | 1.25   | .91    | 2.01  | .91   |
| Farm irrigation system 3/          | do     | .85              | .47    | 1.91  | 1.58  | .78    | .48    | 1.50  | .84   |
| Drainage 3/                        | do     | .67              | .08    | ----- | ----- | -----  | -----  | ----- | ----- |
| Total                              | do     | 3.50             | 1.45   | 4.27  | 3.52  | 2.03   | 1.39   | 4.82  | 3.18  |

1/ Excludes lands in the present pump area.

2/ Land, land clearing, and land leveling amortized over a 100-year period at 5 percent interest (factor .05038).

3/ Farm irrigation system and drainage amortized over a 50-year period at 5 percent interest (factor .05478).

Based on price projections by the U. S. Department of Agriculture, September 1957.





Projected additional investment in land, land improvements, and development of farm irrigation systems per irrigable acre, required with project development, for evaluation areas A through H, are \$66.82, \$27.88, \$81.53, \$67.37, \$39.04, \$26.90, \$93.13, and \$61.74, respectively. At 5 percent the annual amortized cost per acre for the total additional investment required would be \$3.50, \$1.45, \$4.27, \$3.52, \$2.03, \$1.39, \$4.82, and \$3.18.

#### Development Period

Benefits from the use of supplemental water would begin to accrue immediately after completion of the project. The 559 acres of nonirrigated land, which are in small, scattered tracts, are projected to be developed in conjunction with land already under irrigation. Development of the 1,559 acres of nonirrigated land, on which new farms are projected to be established is likely to proceed at a slower rate. Several years may elapse before the full level of benefits are attained. The assumption is made for the Silt project that a period of three years will be required before the full level of projected benefits are achieved on the presently irrigated and intermingled new lands, and five years will be required for lands on which new farms are projected. Project benefits are discounted accordingly.

#### Findings

Increased net income per acre with project development for evaluation areas A through H are \$20.52, \$9.67, \$32.54, \$19.61, \$17.40, \$13.90, \$34.71, and \$16.88, respectively (table 19). Annual amortized cost of additional land investment and development ranges from \$4.82 per acre for evaluation area G to \$1.39 for evaluation area F (table 18). Discount factors are based on three- and five-year development periods, an interest rate of 5 percent, and an evaluation period of 100 years.

The present annual equivalent values per acre of direct agricultural benefits for the eight evaluation areas are estimated at \$16.22, \$7.83, \$25.68, \$14.62, \$14.64, \$11.92, \$27.15, and \$12.45, respectively (table 19). The weighted average annual direct agricultural benefits for the 6,278 acres, except for those lands which presently have a full water supply from pumping, are \$15.56 per acre, or \$97,657 annually.

It was assumed that project lands which presently have a full water supply from pumping would have benefits equal to the savings in pumping costs minus abandonment losses for pumping equipment. Evaluation area A has 213 acres of pumplands and evaluation area B 106 acres. On the basis of present pumping costs, direct agricultural benefits from the 319 acres of pumplands are estimated at \$21.55 per acre annually, or \$6,874 for the total acreage.

The weighted average annual direct agricultural benefits are \$15.85 per acre or \$104,531 for the proposed project.





Table 19.- Summary of estimated annual direct agricultural benefits, by evaluation areas, Silt project

| Evaluation area:Land area: |          |          |           |                                   |          |         |  |          |         |                 |          |       |                    |                     |  |
|----------------------------|----------|----------|-----------|-----------------------------------|----------|---------|--|----------|---------|-----------------|----------|-------|--------------------|---------------------|--|
|                            | Acres    | Per acre | Total     | Increased net income with project | Per acre | Total   | Amortized cost of additional land investment and development | Per acre | Total   | Direct benefits | Per acre | Total | Discount factor 1/ | Net direct benefits |  |
| A                          | 2/ 3,005 | \$20.52  | \$61,663  | \$3.50                            | \$10,518 | \$17.02 | \$51,145   | 3/.95271 | \$16.22 | \$48,726        |          |       |                    |                     |  |
| B                          | 2/ 1,356 | 9.67     | 13,093    | 1.45                              | 1,966    | 8.22    | 11,147   | 3/.95271 | 7.83    | 10,620          |          |       |                    |                     |  |
| C                          | 657      | 32.54    | 21,379    | 4.27                              | 2,805    | 28.27   | 18,574   | 4/.90844 | 25.68   | 16,873          |          |       |                    |                     |  |
| D                          | 215      | 19.61    | 4,216     | 3.52                              | 757      | 16.09   | 3,459  | 4/.90844 | 14.62   | 3,142           |          |       |                    |                     |  |
| E                          | 181      | 17.40    | 3,149     | 2.03                              | 367      | 15.37   | 2,782  | 3/.95271 | 14.74   | 2,650           |          |       |                    |                     |  |
| F                          | 177      | 13.90    | 2,460     | 1.39                              | 246      | 12.51   | 2,214  | 3/.95271 | 11.92   | 2,110           |          |       |                    |                     |  |
| G                          | 341      | 34.71    | 11,836    | 4.82                              | 1,644    | 29.89   | 10,192   | 4/.90844 | 27.15   | 9,226           |          |       |                    |                     |  |
| H                          | 346      | 16.88    | 5,841     | 3.18                              | 1,100    | 13.70   | 4,741  | 4/.90844 | 12.45   | 4,310           |          |       |                    |                     |  |
| Total                      | 6,278    | \$19.70  | \$123,657 | \$3.09                            | \$19,403 | \$16.61 | \$104,254  |          | \$15.56 | \$97,657        |          |       |                    |                     |  |
| Present pump-lands 2/      | 319      |          |           |                                   |          |         |  |          | \$21.55 | \$6,874         |          |       |                    |                     |  |
| Project total              | 6,597    |          |           |                                   |          |         |  |          | \$15.85 | \$104,531       |          |       |                    |                     |  |

1/ At 5 percent. Present annual equivalent value per \$1.00 of benefits accruing during a 100-year period.  
2/ Benefits figured separately on 319 acres of land in evaluation areas A and B which presently have a full supply from pumping but will be included in the project. Of the 319 acres, 213 are in evaluation A and 106 in evaluation area B.  
3/ Assumes a 3-year development period.  
4/ Assumes a 5-year development period.

Based on price projections by the U. S. Department of Agriculture, September 1957.



## Prospective Farm Incomes

Estimates of prospective farm incomes were made for several types and sizes of farms with the proposed project development. Farm incomes were estimated for grade A dairy, range beef, feeder calf, farm-flock of sheep, and cash-crop farms.

Budgets were developed for the following farm types and evaluation areas: range beef on evaluation areas A, B, E, and F; grade A dairy on evaluation areas A and C; feeder calves on evaluation areas A, B, and H; farm-flock of sheep on evaluation areas A, B, and G; and cash-crop farms on evaluation areas A and G.

Many kinds of input-output and price information are needed for farm budgets, among them labor requirements, machinery and building needs, land investment, and feed requirements. Published research in similar irrigated areas was relied upon. These data were supplemented by information collected from farmers in the project and nearby areas.

## Livestock Enterprises and Production Rates

Sales of livestock and livestock products likely will be the predominant sources of income on the project. Project development probably will effect no basic change in the livestock economy of the area, but will however, result in an increase in feed crops and pasture available for livestock. Because of the increased feed supply, numbers of dairy cows, farm sheep, and feeder calves will be increased. It is anticipated also that development of the project will increase the acreage of sugar beets and the number of cash-crop farms in the area.

A production rate of 325 pounds of butterfat per dairy cow is assumed. Feeder steers are assumed to gain 390 pounds and feeder heifers 375 pounds in 11 months. Farm ewes are assumed to produce a 90-pound grass-fat lamb and 10 pounds of wool each. Beef cows are assumed to produce calves averaging 393 pounds.

## Types of Farms

Projected types of farms with project development are based on the future market for each agricultural commodity, existing types of farms on the project, and available Federal grazing permits. Among the farms surveyed, four types predominated--range beef, feeder calf, sheep, and cash-crop. The feeder calf and sheep farms utilized most of the forage and grain crops produced. Cash-crop farms produced primarily grain, sugar beets, and alfalfa for sale.

Brief descriptions of the projected farm types follow:

Range beef - Part of the feed supply is furnished by Federal grazing permits, which limit the number of breeding cows to the equivalent of twelve 134-cow herds. The irrigated land serves as a winter feed base for the breeding herd and summer pasturage for yearlings. Sale of calves and grass-fat long yearlings is the principal source of income.





Development of the project is not expected to result in an increase in the number of beef farms with range permits, or in the number of cows in the breeding herds on these farms.

Grade A dairy - The analysis of dairy enterprises is based on 45 cows per farm. Labor requirements are near maximum for a family-size operation. Seventy-three percent of the milk produced is sold at a grade A price and 27 percent at a grade C price. All milk will be produced under grade A standards and sold to grade A plants.

Feeder calf - Calves are purchased in fall from owners of range herds, wintered and grazed on irrigated pasture the following summer and sold as grass-fat long yearlings in the fall. The size of herd used in the analysis was 150 head.

Farm-flock sheep - Farm flocks consist of 350 mature ewes per farm. sale of grass-fat lambs and wool is the principal source of income.

Cash-crop farms - Alfalfa hay and small grains are produced and sold to ranchers and dairymen on the project and surrounding areas. Sugar beets are also produced on these farms.

### Capital Requirements

Projected capital requirements on several farm types on the Silt project are shown in table 20. Capital requirements on beef farms vary from \$77,500 to \$88,000. Grade A dairy farms require capital ranging from \$67,000 to \$89,000. Capital needs for feeder calf operations vary from \$48,500 to \$72,000. Capital needed for sheep farms varies from \$45,000 to \$68,000. Needs on cash-crop farms range from \$36,500 to \$55,000. These figures represent the cost of new structures and equipment and assume a farm residence value of \$10,000.

Farmers who are presently on the Silt project have most of the capital items needed, with the possible exception of additional land development and expansion of livestock numbers. New farms will require most of the capital items listed except for the investment shown for present land and water supply. New farms will require approximately \$20,000 less capital than present farms because of the large investment in present water supply.

### Return to Operator and Family Labor and Management

An appraisal of the adequacy of projected farm incomes requires a guide or standard in terms of returns to operator and family labor and management. An average return of \$3,100 for essentially full-time family-type farms has been considered an acceptable minimum. This amount is used as a general guide in appraising the adequacy of prospective farm incomes. For farms with greater or less than average operator and family labor inputs, capital requirements, or managerial skills, this return would vary accordingly. The farm dwelling and domestic water supply system are not included as farm expenses or farm receipts in the budget analysis.





Table 20.- Capital investment for illustrative farm types, with project development, by evaluation areas, Silt project

| Item                                     | : Unit | : Range | : Grade A: | : Feeder: Farm-flock |         |        |
|--|--------|---------|------------|----------------------|---------|--------|
|  |        | : beef  | : dairy    | : Cash crop:         | calves: | sheep  |
| Evaluation area                          |        | A       | A          | A                    | B       | B      |
| Irrigable land (project)                 | Acre   | 130     | 130        | 130                  | 150     | 150    |
| Irrigable permanent pasture (nonproject) | do     | 15      | 15         | -----                | 11      | 11     |
| Land and present water supply            | Dollar | 32,619  | 32,619     | 31,494               | 30,086  | 30,086 |
| Farm buildings and improvements 1/       | do     | 5,032   | 14,562     | 2,283                | 4,540   | 7,463  |
| Equipment 1/                             | do     | 11,675  | 18,048     | 11,245               | 11,313  | 11,313 |
| Livestock                                | do     | 28,825  | 13,725     | -----                | 12,750  | 6,420  |
| Total farm                               | do     | 78,151  | 78,954     | 45,022               | 58,689  | 55,282 |
| Residence 2/                             | do     | 10,000  | 10,000     | 10,000               | 10,000  | 10,000 |
| Total needs                              | do     | 88,151  | 88,954     | 55,022               | 68,689  | 65,282 |

1/ Cost of new structures and equipment.

2/ Value assumed for purposes of approximately total capital requirements.

Based on price projections by the U. S. Department of Agriculture, September 1957.

The \$3,100 does not necessarily represent the total income received by the farm family from operation of the farm business. In addition to return for labor and management, the farm family will receive a return on equity owned in the farm business. Return on investment owned by the operator, in addition to returns for labor and management, would be available for family living expenses, including income and social security taxes, savings, and retirement of debt.

### Findings

Net incomes for the various sizes and types of farms, from tables 21A, 21B, 21C, and 21D are summarized below:

| Evaluation area | Range<br>beef | Grade A<br>dairy | Feeder<br>calves | Farm-flock<br>sheep | Cash crop |
|-----------------|---------------|------------------|------------------|---------------------|-----------|
| A               | \$4,297       | \$7,665          | \$6,199          | \$3,903             | \$5,448   |
| B               | 4,448         | -----            | 4,457            | 3,934               | -----     |
| C               | -----         | 8,606            | 7,180            | -----               | -----     |
| D               | -----         | -----            | 5,412            | -----               | -----     |
| E               | 5,257         | -----            | -----            | -----               | -----     |
| F               | 5,010         | -----            | -----            | -----               | -----     |
| G               | -----         | -----            | -----            | 6,563               | 6,512     |
| H               | -----         | -----            | 5,094            | 4,576               | -----     |



Table 21A.- Projected agricultural incomes and selected sizes and organizational items for farm budgets by type of farm, evaluation area A, Silt project

| Item                                  | :      | :      | Evaluation area A                   |        |         |           |       |
|---------------------------------------|--------|--------|-------------------------------------|--------|---------|-----------|-------|
|                                       |        |        | : Range :Grade A:Feeder:Farm-flock: |        |         |           |       |
|                                       |        |        | : Unit                              | : beef | : dairy | : calves: | sheep |
| Total land                            | Acre   | 145.0  | 145.0                               | 145.0  | 145.0   | 130.0     |       |
| Alfalfa                               | do     | 71.5   | 50.0                                | 21.0   | 40.0    | 69.0      |       |
| Rotation pasture                      | do     | 15.5   | 37.0                                | 48.0   | 47.0    | -----     |       |
| Corn silage                           | do     | 17.5   | 17.5                                | 14.0   | 17.5    | -----     |       |
| Barley                                | do     | 17.5   | 17.5                                | 14.0   | 17.5    | 28.0      |       |
| Sugar beets                           | do     | -----  | -----                               | 25.0   | -----   | 25.0      |       |
| Farmstead, etc.                       | do     | 8.0    | 8.0                                 | 8.0    | 8.0     | 8.0       |       |
| Permanent pasture (non-project lands) | do     | 15.0   | 15.0                                | 15.0   | 15.0    | -----     |       |
| Productive livestock                  | Number | 134    | 45                                  | 150    | 350     | -----     |       |
| Operator and family labor             | Hour   | 3,217  | 4,451                               | 2,229  | 2,595   | 1,836     |       |
| Investment                            | Dollar | 73,463 | 67,497                              | 56,196 | 52,063  | 41,076    |       |
| Land                                  | do     | 32,619 | 32,619                              | 32,619 | 32,619  | 31,494    |       |
| Buildings and improvements            | do     | 3,019  | 8,737                               | 2,776  | 4,513   | 1,370     |       |
| Machinery                             | do     | 7,005  | 10,829                              | 7,166  | 7,005   | 6,747     |       |
| Livestock                             | do     | 28,825 | 13,725                              | 12,750 | 6,420   | -----     |       |
| Other                                 | do     | 1,995  | 1,587                               | 885    | 1,506   | 1,465     |       |
| Farm receipts                         | Dollar | 14,932 | 20,216                              | 16,855 | 11,984  | 13,500    |       |
| Crop sales                            | do     | 2,491  | 2,861                               | 6,746  | 2,326   | 13,400    |       |
| Livestock and products                | do     | 12,341 | 17,149                              | 10,009 | 9,558   | -----     |       |
| Other                                 | do     | 100    | 206                                 | 100    | 100     | 100       |       |
| Farm expenses <u>1/</u>               | Dollar | 6,962  | 9,176                               | 7,846  | 5,478   | 5,998     |       |
| Farm income <u>2/</u>                 | Dollar | 7,970  | 11,040                              | 9,009  | 6,506   | 7,502     |       |
| Interest on investment <u>3/</u>      | Dollar | 3,673  | 3,375                               | 2,810  | 2,603   | 2,054     |       |
| Adjusted farm income <u>4/</u>        | Dollar | 4,297  | 7,665                               | 6,199  | 3,903   | 5,448     |       |

1/ Does not include interest on capital or annual water costs, including O&M.

2/ Return to operator and family labor and management, capital and irrigation water.

3/ At 5 percent, excluding investment in project water.

4/ Return to operator and family labor and management, project irrigation water, and total O&M charges.

Based on price projections by the U. S. Department of Agriculture, September 1957.





Table 21B.- Projected agricultural incomes and selected sizes and organizational items for farm budgets by type of farm, evaluation areas B and C, Silt project

| Item                                  | :      | : Evaluation area B |        |           | : Evaluation area C |          |
|---------------------------------------|--------|---------------------|--------|-----------|---------------------|----------|
|                                       |        | : Range :           |        | :         | : Grade A           | : Feeder |
|                                       |        | : Unit              | : beef | : calves: | Sheep               | : dairy  |
| Total land                            | Acre   | 161,0               | 161.0  | 161.0     | 135.0               | 135.0    |
| Alfalfa                               | do     | 82.0                | 45.0   | 46.0      | 48.0                | 19.0     |
| Rotation pasture                      | do     | 19.0                | 56.0   | 55.0      | 43.0                | 54.0     |
| Corn silage                           | do     | -----               | -----  | -----     | 18.0                | 14.5     |
| Barley                                | do     | 40.0                | 40.0   | 40.0      | 18.0                | 14.5     |
| Sugar beets                           | do     | -----               | -----  | -----     | -----               | 25.0     |
| Farmstead, etc.                       | do     | 9.0                 | 9.0    | 9.0       | 8.0                 | 8.0      |
| Permanent pasture (non-project lands) | do     | 11.0                | 11.0   | 11.0      | -----               | -----    |
| Productive livestock                  | Number | 134                 | 150    | 350       | 45                  | 150      |
| Operator and family labor             | Hour   | 3,412               | 2,535  | 2,894     | 4,441               | 2,209    |
| Investment                            | Dollar | 70,179              | 53,335 | 48,854    | 45,806              | 34,503   |
| Land                                  | do     | 30,086              | 30,086 | 30,086    | 11,007              | 11,007   |
| Buildings and improvements            | do     | 2,934               | 2,724  | 4,478     | 8,683               | 2,722    |
| Machinery                             | do     | 6,788               | 6,788  | 6,788     | 10,829              | 7,166    |
| Livestock                             | do     | 28,825              | 12,750 | 6,420     | 13,725              | 12,750   |
| Other                                 | do     | 1,546               | 987    | 1,082     | 1,562               | 858      |
| Farm receipts                         | Dollar | 14,849              | 12,756 | 11,670    | 20,147              | 16,891   |
| Crop sales                            | do     | 2,408               | 2,647  | 2,012     | 2,792               | 6,782    |
| Livestock and products                | do     | 12,341              | 10,009 | 9,558     | 17,149              | 10,009   |
| Other                                 | do     | 100                 | 100    | 100       | 206                 | 100      |
| Farm expenses <u>1/</u>               | Dollar | 6,892               | 5,632  | 5,293     | 9,251               | 7,986    |
| Farm income <u>2/</u>                 | Dollar | 7,957               | 7,124  | 6,377     | 10,896              | 8,905    |
| Interest on investment <u>3/</u>      | Dollar | 3,509               | 2,667  | 2,443     | 2,290               | 1,725    |
| Adjusted farm income <u>4/</u>        | Dollar | 4,448               | 4,457  | 3,934     | 8,606               | 7,180    |

1/ Does not include interest on capital or annual water costs, including O&M.

2/ Return to operator and family labor and management, capital and irrigation water.

3/ At 5 percent, excluding investment in project water.

4/ Return to operator and family labor and management, project irrigation water, and total O&M charges.

Based on price projections by the U. S. Department of Agriculture, September 1957.





Table 21C.- Projected agricultural incomes and selected sizes and organizational items for farm budgets by type of farm, evaluation areas D, E, and F, Silt project

| Item                                  | Unit   | Evaluation    |            |            |
|---------------------------------------|--------|---------------|------------|------------|
|                                       |        | area D        | area E     | area F     |
|                                       |        | Feeder calves | Range beef | Range beef |
| Total land                            | Acre   | 155.0         | 179.0      | 205.0      |
| Alfalfa                               | do     | 43.0          | 80.0       | 94.5       |
| Rotation pasture                      | do     | 61.0          | 11.0       | 10.5       |
| Corn silage                           | do     | -----         | 18.0       | -----      |
| Barley                                | do     | 42.0          | 18.0       | 41.0       |
| Sugar beets                           | do     | -----         | -----      | -----      |
| Farmstead, etc.                       | do     | 9.0           | 8.0        | 9.0        |
| Permanent pasture (non-project lands) | do     | -----         | 44.0       | 50.0       |
| Productive livestock                  | Number | 150           | 134        | 134        |
| Operator and family labor             | Hour   | 2,537         | 3,285      | 3,458      |
| Investment                            | Dollar | 33,631        | 64,085     | 62,586     |
| Land                                  | do     | 10,442        | 22,995     | 22,170     |
| Buildings and improvements            | do     | 2,692         | 3,208      | 3,172      |
| Machinery                             | do     | 6,788         | 7,005      | 6,788      |
| Livestock                             | do     | 12,750        | 28,825     | 28,825     |
| Other                                 | do     | 959           | 2,052      | 1,631      |
| Farm receipts                         | Dollar | 12,897        | 15,213     | 14,909     |
| Crop sales                            | do     | 2,788         | 2,772      | 2,468      |
| Livestock and products                | do     | 10,009        | 12,341     | 12,341     |
| Other                                 | do     | 100           | 100        | 100        |
| Farm expenses <u>1/</u>               | Dollar | 5,803         | 6,752      | 6,770      |
| Farm income <u>2/</u>                 | Dollar | 7,094         | 8,461      | 8,139      |
| Interest on investment <u>3/</u>      | Dollar | 1,682         | 3,204      | 3,129      |
| Adjusted farm income <u>4/</u>        | Dollar | 5,412         | 5,257      | 5,010      |

1/ Does not include interest on capital or annual water costs, including O&M.

2/ Return to operator and family labor and management, capital and irrigation water.

3/ At 5 percent, excluding investment in project water.

4/ Return to operator and family labor and management, project irrigation water, and total O&M charges.

Based on price projections by the U. S. Department of Agriculture, September 1957.



Table 21D.- Projected agricultural incomes and selected sizes and organizational items for farm budgets by type of farm, evaluation areas G and H, Silt project

| Item                                 | Unit   | : Evaluation area : |             | Evaluation area |         |
|--------------------------------------|--------|---------------------|-------------|-----------------|---------|
|                                      |        | : G :               |             | H               |         |
|                                      |        | : Sheep             | : Cash crop | : Feeder calves | : Sheep |
| Total land                           | Acre   | 140.0               | 140.0       | 160.0           | 160.0   |
| Alfalfa                              | do     | 20.0                | 77.0        | 40.0            | 41.0    |
| Rotation pasture                     | do     | 57.0                | -----       | 67.0            | 66.0    |
| Corn silage                          | do     | 15.0                | -----       | -----           | -----   |
| Barley                               | do     | 15.0                | 30.0        | 43.0            | 43.0    |
| Sugar beets                          | do     | 25.0                | 25.0        | -----           | -----   |
| Farmstead, etc.                      | do     | 8.0                 | 8.0         | 10.0            | 10.0    |
| Permanent pasture (non-project land) | do     | -----               | -----       | -----           | -----   |
| Productive livestock                 | Number | 350                 | -----       | 150             | 350     |
| Operator and family labor            | Hour   | 2,779               | 1,909       | 2,525           | 2,897   |
| Investment                           | Dollar | 32,107              | 22,778      | 32,972          | 28,505  |
| Land                                 | do     | 13,038              | 13,038      | 9,878           | 9,878   |
| Buildings and improvements           | do     | 4,049               | 1,403       | 2,719           | 4,470   |
| Machinery                            | do     | 7,166               | 6,747       | 6,788           | 6,788   |
| Livestock                            | do     | 6,420               | -----       | 12,750          | 6,420   |
| Other                                | do     | 1,434               | 1,590       | 837             | 949     |
| Farm receipts                        | Dollar | 15,919              | 13,838      | 12,967          | 11,880  |
| Crop sales                           | do     | 6,261               | 13,738      | 2,858           | 2,222   |
| Livestock and products               | do     | 9,558               | -----       | 10,009          | 9,558   |
| Other                                | do     | 100                 | 100         | 100             | 100     |
| Farm expenses <u>1/</u>              | Dollar | 7,751               | 6,187       | 6,224           | 5,879   |
| Farm income <u>2/</u>                | Dollar | 8,168               | 7,651       | 6,743           | 6,001   |
| Interest on investment <u>3/</u>     | Dollar | 1,605               | 1,139       | 1,649           | 1,425   |
| Adjusted farm income <u>4/</u>       | Dollar | 6,563               | 6,512       | 5,094           | 4,576   |

1/ Does not include interest on capital or annual water costs, including O&M.

2/ Return to operator and family labor and management, capital and irrigation water.

3/ At 5 percent, excluding investment in project water.

4/ Return to operator and family labor and management, project irrigation water, and total O&M charges.

Based on price projections by the U. S. Department of Agriculture, September 1957.





These incomes are available as return to the operator and his family for their management and labor, project irrigation water, and for payment of all operation and maintenance costs. Many farms will have larger or smaller net incomes than those shown here. The conclusion from this analysis is that the income prospects for these fully developed farms would be adequate to provide a reasonably satisfactory level of living and to permit some payment for costs of irrigation water.

#### Relationship Between Farm-Income and Crop-Production Budgets

Two types of budgets were used in the economic analyses of this project. Farm-income budgets were used in appraising the prospects for a successful, stable agriculture and also as a basis for the crop-production budgets used in estimating direct agricultural benefits. Cropping patterns assumed in the benefit analysis are the same as those used in the analysis of prospective farm incomes; thus they reflect the need for hay, pasture, and other feed crops in livestock enterprises. In the benefit analysis it was assumed that forage crops would be purchased by the livestock enterprises. This assumption also governed estimates of forage prices and cropping patterns.

The estimate of direct agricultural benefits was based on crop-production budgets. The results are shown below by evaluation areas together with benefit estimates based on farm-income budgets. Costs per unit of inputs used in production were the same in the farm-income and crop-production budgets. Distribution of farm types by acreage assumed in both analysis are as follows: (1) With the project--range beef, 26 percent; grade A dairy, 12 percent; feeder calves, 28 percent; farm-flock sheep, 16 percent; and cash crop, 18 percent; (2) Without the project--range beef, 35 percent; grade A dairy, 10 percent; feeder calves, 21 percent; farm-flock sheep, 14 percent; and cash crop, 20 percent. Estimates of net direct agricultural benefits are \$15.85 per acre for the crop-production budgets and \$16.61 per acre for the farm-income budgets.

| <u>Evaluation area</u> | <u>Crop-production<br/>budgets</u> | <u>Farm-income<br/>budgets</u> |
|------------------------|------------------------------------|--------------------------------|
| A                      | \$16.22                            | \$17.17                        |
| B                      | 7.83                               | 8.27                           |
| C                      | 25.68                              | 28.81                          |
| D                      | 14.62                              | 15.08                          |
| E                      | 14.64                              | 17.17                          |
| F                      | 11.92                              | 13.60                          |
| G                      | 27.15                              | 25.39                          |
| H                      | 12.45                              | 10.28                          |
| Pump area              | 21.55                              | 21.55                          |
| Project                | 15.85                              | 16.61                          |

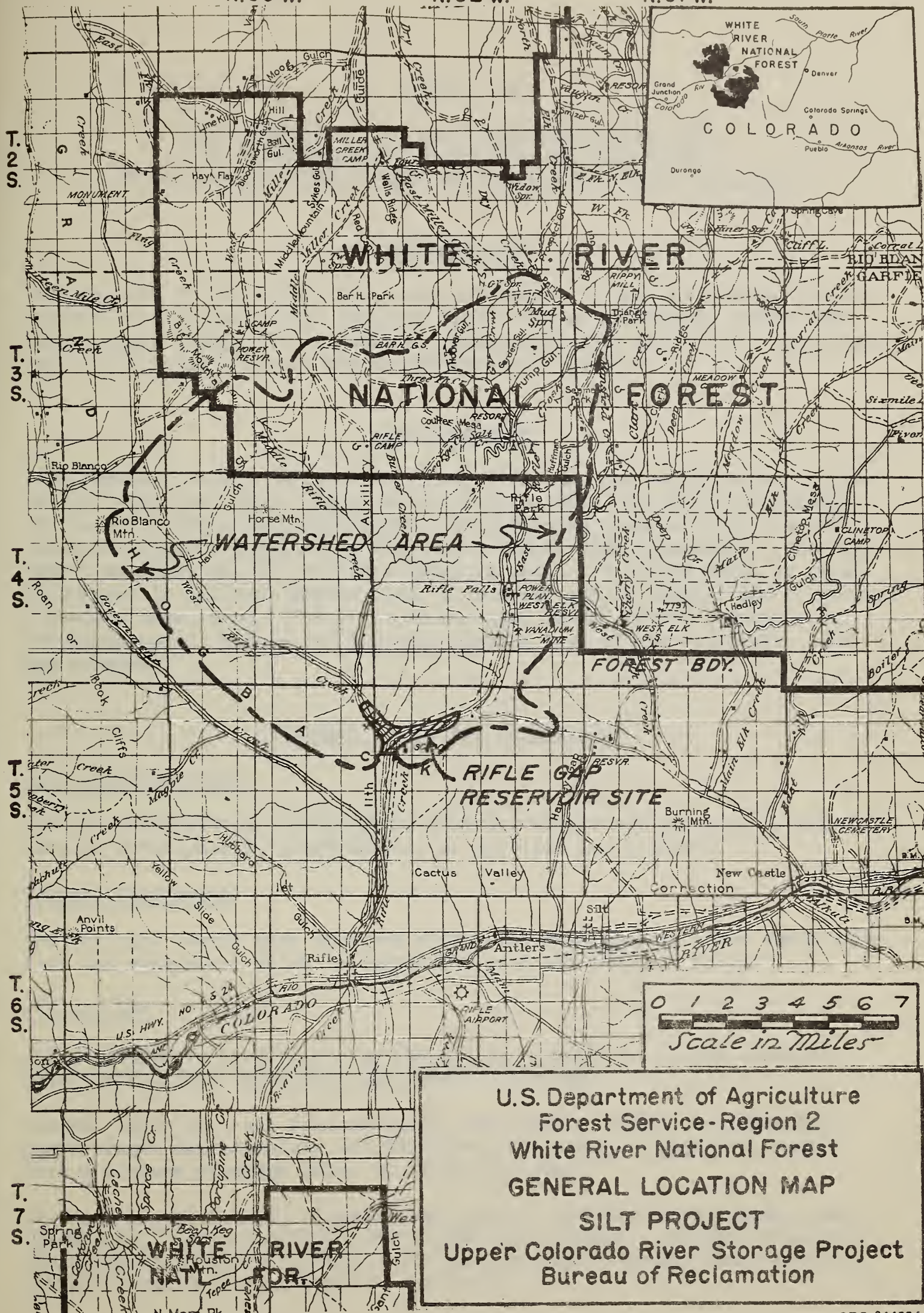




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## CHAPTER III

### RELATIONSHIP OF THE SILT PARTICIPATING PROJECT TO THE MANAGEMENT, PROTECTION AND USE OF THE WHITE RIVER NATIONAL FOREST AND NONFEDERAL FOREST RESOURCES

#### Introduction

This section of the report considers the impact of the Silt Participating Project on the White River National Forest and on nonfederal forest and forest-range lands. It is aimed at determining what facilities, resources, and uses will be affected and at evaluating these effects.

#### Area Concerned

The proposed project features including Rifle Gap Dam and Reservoir, Grass Valley Canal, and Davie Ditch are entirely outside the exterior boundary of the White River National Forest. The proposed reservoir is at a distance of seven to eight miles from the national forest boundary. The watershed area above the dam on Rifle Creek is about 130 square miles of which 35 percent is national forest land, 43 percent public domain, and 22 percent privately owned land. There are no forested lands, either federally or privately owned, within the 300 acre flowage area of the reservoir. See map attached.

#### Present Status and Current Use

##### Existing Facilities

Project construction and operation will not affect any existing Forest Service developments, improvements, or services now provided.

##### Current Management

The national forest area involved within the watershed is under administration and management which is compatible with the proposed project.

##### Current Use

The watershed is used primarily for growing timber and forage, and for water production, recreation and wildlife habitat.

Annual timber cut, all from national forest lands within the watershed, has averaged approximately 500,000 board feet over the past five years, with a minimum stumpage value of \$3,300 per year.

On the national forest, 16 permittees graze 1,150 cattle and horses and 3,100 sheep, for a total of 5,050 animal unit months. Receipts from this use amounted to \$2,755 in 1958. Private and public domain lands are also grazed but at different times of the year.





Recreation use on national forest lands within the watershed is moderate; it is estimated the use for hunting, fishing, camping, picnicking and sight-seeing has risen to 7,800 mandays annually. Heavy recreation use occurs on a scenic section of East Rifle Creek between the national forest boundary and the reservoir site. This is the Rifle Mountain Park, an area maintained by the City of Rifle for picnicking, camping, fishing and sight-seeing.

One reservoir, 3 ditches, 15 stockwater ponds, 5 pastures and cabins, one resort, and one summer home are authorized under special use permits on national forest lands within the watershed. These will not be affected by the project.

At present, there are no Forest Service rights-of-way, or withdrawals within the area.

There is very little mining activity, including oil and gas leasing within the area. There are some mining claims, but little or no development work has been done.

#### Estimated Future Status Without Project Developments

Timber harvest will continue at about the present rate on national forest lands. There will be no significant amount of cutting on nonfederal forest lands.

Adjustments in grazing use on the national forest will be continued to bring stocking and actual use into agreement with carrying capacities and proper use of the range. This action will provide better protection of the project watershed.

The trend of increasing recreation use will continue. An estimate of 35 percent increase in the next five years is conservative.

The forest and forest-range lands in other Federal and private ownerships will continue to be used for grazing, forestry, wildlife, and recreation purposes.

#### Impacts of Project Construction and Operation on the National Forest (Estimated Future Use With the Project Development)

Construction and operation of this project will have no significant effect upon general administration, management, and protection of the Rifle Ranger District, White River National Forest.

#### General Administration

The project will not require any change in principles or objectives of administration or management. No changes or additions will be necessary in forest improvements needed for administration or services now provided on the national forest.





## Protection

No additional improvements for fire prevention or control will be needed.

## Resource Use and Development

The proposed Rifle Gap Reservoir will attract visitors for picnicking, boating, and fishing. Some of this increased recreational use will probably also be extended to national forest lands. However, this increased use is not expected to be heavy and costs of preparing or extending recreational area plans will not be significant.

There will be no conflicts with forest areas such as wilderness, research, or other special areas.

## Losses or Benefits to Resource Values

The project will have no effects on forest resource volumes or values.

## Impacts on Nonfederal Forest and Forest-Range Lands

Construction and operation of this project will have no significant effect upon nonfederal forest and forest-range lands. Flooding of the privately owned ranch lands will not affect any grazing permits or grazing use of national forest lands. The forest-based economy will not be affected. Recreational use, including boating and picnicking, will occur on and around the reservoir and will contribute to the local economy.

## Summary and Findings

1. The proposed Rifle Gap Dam, Reservoir, Canals, and Ditches are outside the boundary of the White River National Forest.
2. As far as can be foreseen at this time, the project will not impair or affect any existing facility or service on national forest lands.
3. There will be no appreciable losses or gains in resource values now provided by forest and forest-range lands of national forest or non-federal ownerships.



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W H I T E

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N A T I O N A L

F O R E S T

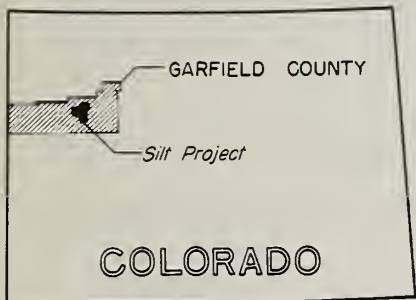
B O U N D A R Y

F O R E S T

Monument  
Pk.

Horse  
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COLORADO

LOCATION MAP

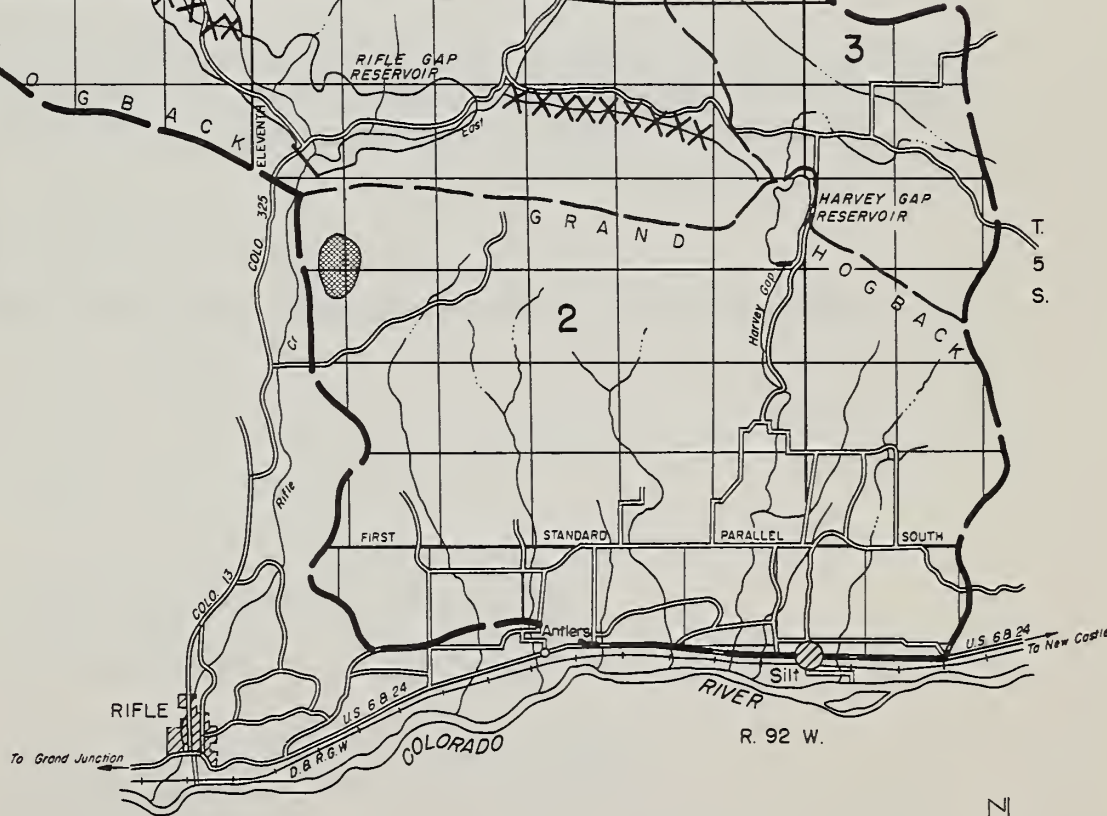
LEGEND

— Subwatershed Boundary  
| Subwatershed Numbers

Stock Trail  
XXXXX Gullies

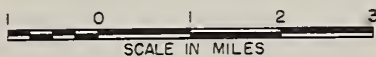
CRITICAL EROSION AREAS

Soil Slides  
Shale Slides



SILT PROJECT WATERSHED  
GARFIELD COUNTY, COLORADO

JUNE 1961







## CHAPTER IV

### RELATIONSHIP OF WATERSHED CONDITIONS TO THE SILT PROJECT

Watershed conditions covered in this report are common to most irrigation projects. They do not materially affect feasibility of the project. However, improvement of watershed conditions will extend the life of the project and reduce operating difficulties and maintenance expenses. These conditions are pointed out here so local, state and federal agencies which deal with watershed lands can orient their programs to the solution of these problems.

#### Location and Size

The watershed affecting the Silt project is northeast of the town of Rifle in Garfield County, Colorado. The watershed is bounded on the west by the Grand Hogback, on the north by the White River drainage divide, on the east by the ridge between East Rifle Creek and Elk Creek, and on the south by U. S. Highway 6-24 (see map). There are about 10 square miles on the Elk Creek drainage east and north of Harvey Gap Reservoir included because it contains project lands.

West Rifle, Middle Rifle and East Rifle Creeks are the main streams in the watershed. The watershed is comprised of 112,000 acres, or 175 square miles, and is divided into three subwatersheds as shown in table 22.

Table 22. - Subwatersheds, Silt project

| Subwatershed<br>number | Drainages  | Square miles |
|------------------------|--|--------------|
| 1                      | Above Rifle Gap Reservoir  | 130          |
| 2                      | Area including project land and facilities draining south from Grand Hogback or through Harvey Gap Reservoir | 35           |
| 3                      | That area in Dry Elk Valley above Harvey Gap Reservoir that drains into Elk Creek                            | <u>10</u>    |
| Total                  |  | 175          |





## Watershed Characteristics

### Topography and Geology

West Rifle, Middle Rifle and East Rifle Creeks make up the triangular shaped watershed that drains into the reservoir proper. Elevation ranges from about 5,800 feet at the confluence of the creeks, to about 9,200 feet on the northwest and northeast summit lands. A large, gently rolling table land characterizes the upper part. Stream canyons dissect the area, becoming steep and broken at lower elevations. The remainder of the watershed comprises those lands lying south of the Grand Hogback to the Cactus Valley Canal north of Highway 6-24 and the west portion of Dry Elk Valley north of Harvey Gap Reservoir.

Thick beds of Pennsylvanian Age limestone characterize the upper watershed. Sandstones and shales (mostly Permian formations), dominate the eastern and southern portion. Mancos shale outcrops follow West Rifle Creek to the head and make up a sizable area in the southeast corner of the watershed. Dakota and Jurassic sandstone and shale lies above the Mancos and occurs in the same area at slightly higher elevations. The Grand Hogback (Mesa Verde Age), flanks the west side of the watershed and divides the project land between Dry Elk Valley and Harvey Mesa.

Valley floors are generally narrow. Near the reservoir pool area and for short distances up West Rifle and East Rifle Creeks, alluvial bottoms are wide enough to cultivate. The alluvial soils range from loam to clay loam and are derived from reworked sandstone and shale. The Harvey Mesa area consists of wind-lain and alluvial soils overlying Wasatch shales and sandstone. Dry Elk Valley is a small upland valley of reworked loam and clay soil which runs eastward from Harvey Gap Reservoir.

### Precipitation and Runoff

Annual precipitation varies from about eleven inches on the project's irrigated lands to nearly thirty inches in the higher mountain areas. Approximately fifty percent of the precipitation is received as snow in the winter. June is the driest month. Some high-intensity rainstorms occur in July, August and September.

Peak streamflows can be expected from snowmelt during April and May, and from high intensity rains in July, August and September.

### Vegetative Cover

Vegetative cover for the watershed, by principal type, is shown in table 23.



Table 23. - Vegetative types, watershed area, Silt project

| Type                 | Square miles |
|----------------------|--------------|
| Conifer timber       | 5            |
| Aspen                | 20           |
| Oakbrush             | 40           |
| Other mountain brush | 20           |
| Sagebrush            | 20           |
| Grass                | 23           |
| Pinon juniper        | <u>30</u>    |
| Subtotal             | 158          |
| Naturally barren     | 4            |
| Cultivated land      | <u>13</u>    |
| Total                | 175          |

### Soils and Erosion

Drainages are characterized by steep slopes with a thin soil cover. Deeper soil is found in the narrow valley bottoms of alluvial deposits and of the upper park areas. The main streams have moderate gradients while the feeder tributaries are steeper. Lands with poor and very poor vegetative conditions are losing soil.

Upper elevation zones have good vegetative cover with practically no erosion except for roads, trails and a stock driveway. In East Rifle Creek and its tributaries, many inactive beaver ponds are deteriorating and releasing the accumulated sediment.

There is an intermediate brush zone type, predominantly oak, which has deep soils, steep slopes, and slight erosion. Most of the lower elevation zones are classified as wild lands having raw, highly erosive soils on steep slopes with a sparse cover of pinon and juniper.

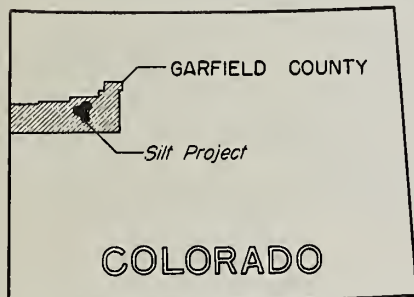
Valley floors above the reservoir site have been deeply gullied. Erosion at the present time is active on all meandering sections of these gullies; however, some sections appear to be in the process of stabilization. Most of these areas are privately owned and the land use is dry and irrigated farming. Improper use and disposal of irrigation water continues to aggravate the problem.

### Land Use

A major portion of the upper watershed is federally owned and is used for










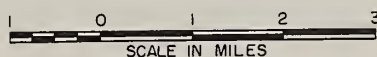
LOCATION MAP

### LEGEND

- |  |  |
|--|--|
|  | Privately owned lands, patented, R.R., mining and small holding claims, corporations, cities, etc.   |
|  | Lands administered by the Bureau of Land Management: Withdrawals and Reservations primarily under B. L. M. jurisdiction and vacant public lands. |
|  | National Forest Lands including lands in trust administered by the U. S. Forest Service.   |

LAND STATUS MAP  
SILT PROJECT WATERSHED  
GARFIELD COUNTY, COLORADO

JUNE 1961







grazing of sheep, cattle, and big game animals. Timber production, wild-life, and recreation are other uses of this area. Lower elevations are about equally divided between privately owned land and public domain. About one-fourth of the privately owned land is irrigated. A very small percentage of land is being used for dry farming. Nearly three-fourths of the area is used for grazing by domestic livestock and big game animals.

Mining and oil explorations are being conducted within the watershed area. If these explorations lead to development of mineral and oil resources, watershed conditions will be affected.

### Land Ownership

Land ownership is shown in table 24.

Table 24. - Land ownership, watershed area, Silt project

| Class of ownership   | Square miles | Percent of total |
|----------------------|--------------|------------------|
| Federal land         |              |                  |
| Public domain        | 65           | 37               |
| National forest land | 45           | 26               |
| Private              | <u>65</u>    | <u>37</u>        |
| Total                | 175          | 100              |

### Watershed Problems

#### Subwatershed No. 1 (The area above the Rifle Gap Dam Site)

Sediment which may be carried into the reservoir by the major drainages is the most significant problem in this subwatershed.

Contributing factors to the sedimentation problem are: (1) Erosion of the Mancos shale areas, (2) sheet erosion where proper grazing use and distribution are not being practiced, (3) farming practices on lands near the severely gullied areas on the lower drainages, (4) roads, trails, driveways, drainages and recreation use, (5) loss of protective cover by fire, (6) abandoned beaver dams that break and contribute accumulated soil material to the stream.

#### Subwatersheds No. 2 and 3 (That portion east and south of the Rifle Gap Reservoir including the project irrigated lands)

Significant watershed problems in this area are flood water and sediment



that are carried into the irrigation systems. Factors aggravating these conditions are the erosive types of soils, steep sparsely vegetated slopes, and the occurrence of thunderstorms and rapidly melting snow.

### Land Treatment

Land treatment measures that will help to solve these watershed problems are listed in table 25.

Table 25. - Land treatment, Silt project watershed

| Treatment  | Unit           | Estimated Amounts by Land Ownership 1/ |           |              |
|--|----------------|--|-----------|--------------|
|  |                | Private                                | Bureau of | National     |
|  |                | Lands                                  | Land Mgt. | Forest Lands |
| Proper use of range resource   |                |  |           |              |
| A. Domestic livestock  | Acres          | 10,000                                 | 10,000    | 4,000        |
| B. Big game  | Acres          | 28,700                                 | 41,600    | 28,800       |
| Stockwater Development   | Number         | 30                                     | 25        | 10           |
| Gully Control (Erosion control dams)   | Number         | 130                                    | 300       |              |
| Irrigated Land Practices   | Acres          | 12,900                                 |           |              |
| Fences for Grazing Control   | Miles          | 10                                     | 15        | 20           |
| Brush and Weed Control   | Acres          | 3,000                                  | 1,000     | 4,000        |
| Range Reseeding  | Acres          | 1,000                                  | 750       |              |
| Relocation, betterment and maintenance of roads, trails, and stock driveways |                |  |           |              |
| a. Roads   | Miles          | 20                                     | 35        | 30           |
| b. Trails  | Miles          |  | 10        | 5            |
| c. Driveways   | Miles          | 3                                      | 3         | 7            |
| Proper beaver management   | Mile of Stream |  |           | 7            |
| Fire Protection  | Acres          | (All ownerships = total 112,000)       |           |              |

1/ Estimates prepared by Soil Conservation Service, Bureau of Land Management and Forest Service.





## Federal Lands

### National Forest Lands

Protection and conservation measures on national forest lands can be accomplished by proper land use and proper management of all resources. The greater amount of protection will be accomplished through proper management of domestic livestock and big game. Grazing adjustments of domestic livestock and big game will be made in accordance with range analysis surveys.

Beaver management plans are in the process of preparation in cooperation with the U. S. Fish and Wildlife Service and the Colorado Game and Fish Department. Upon completion of this plan, an action program will be initiated to bring the population of beaver into balance with the resources and watershed requirements.

The Forest Service is in the process of preparing a multiple use land management plan for the Rifle Ranger District, which includes the watershed area. This plan when completed will provide direction and policy for proper land management within the watershed.

Location of roads, trails and stock driveways within the national forest should be given careful consideration to minimize accelerated erosion.

### Public Domain

The greater portion of public domain lands are in the intermediate and lower elevation zones. The lands in the intermediate zone are predominantly used for grazing of livestock by operators of adjoining private lands. The Bureau of Land Management will complete range analysis studies soon. Many small erosion control dams are being planned in gullies in this area.

Lands in the lower elevation zones are wild lands with such highly erosive soil, steep slopes and sparse cover, that very little can be done for improvement. Lands in the project area which are below these wild lands will need to be protected from flooding and deposition. Grazing-use adjustments will be made wherever necessary to provide watershed protection.

## Private Land

The Soil Conservation Service, through the Bookcliff Soil Conservation District, has assisted in the planning and installation of conservation treatment in the area. This treatment includes improvement of irrigation systems, land leveling and drainage on irrigated lands within farm and ranch units. Treatment on rangelands has not been extensive. Range practices that have been installed are principally stockwater developments, grass management, and small acreages of range seeding.

Many of the farms or ranches within the area have both irrigated and rangelands within their units. The application of conservation work has been





somewhat limited due to deficient irrigation water and a low financial return from farm and ranch operations. About one-third of the landowners within the area have signed cooperative agreements with the Bookcliff Conservation District. Soil Conservation Service technicians have worked with ditch companies and water users in planning and application of irrigation improvements. Much conservation and improvement work remains to be done. As the economic conditions of the area improve, the conservation activities will accelerate.

### Flood Prevention Structural Measures

The high and intermediate elevation zones do not pose any general flood problems to the project. Due to this situation no large flood control structures are required. Wherever critical areas do exist, improved management and use, plus related measures such as fencing, revegetation and small structures, will correct erosion problems.

The lower elevation zone has steep slopes, raw soils and sparse vegetation. Flood prevention structures will be ineffective under these conditions. The amount of flood water will be small due to short slopes and low rainfall.

Canals serving project lands will be affected by runoff from lands in this lower elevation zone. One shale area above a reach of the proposed Davie Ditch is quite critical. Ditch and canal design should provide protection from runoff from these lands.

### Irrigation Aspects

Irrigated lands of the project are interspersed between natural drainageways through the project. Most of these drainageways are well channelized and will contain most flood flows. There will be some bank cutting along edges of cultivated fields that will need attention. The installation of efficient farm irrigation systems, improved irrigation water management and proper disposal of waste water will reduce bank cutting where fields are next to deep channels. Some drainageways may require head stabilization and erosion control structures to protect them from cutting. Proper use and disposal of irrigation water may alleviate some of the subsurface drainage problems that exist within the project area. Assistance is available from Federal, State and local agencies to install necessary irrigation improvement, erosion control, and drainage practices.

### Findings

Watershed conditions do not pose a flood hazard to the project. They do produce sediment which will be deposited in the project reservoir and will cause canal cleaning problems. The Rifle Gap Reservoir is designed to provide storage for 100 years of sediment accumulation without encroachment on the active irrigation capacity. Any reduction in the sediment will lengthen this period. Most of the sediment comes from problem areas which can be improved by watershed treatment measures. Watershed treatment



can be accomplished under programs of federal land administering agencies and by private landowners with assistance normally furnished by Federal and State agencies through Soil Conservation Districts. There should be greater emphasis by all interested parties on proper land management to improve watershed conditions and reduce the sediment problem.





## CHAPTER V

### ACTIVITIES OF THE U. S. DEPARTMENT OF AGRICULTURE PARTICULARLY AFFECTED BY THE SILT PROJECT

#### Introduction

The U. S. Department of Agriculture and the Colorado State University are carrying out a number of agricultural activities in Garfield County, Colorado. With the increased agricultural activity that will accompany the proposed development of the Silt project, these programs will need to be accelerated.

#### Agricultural Extension Education and Information

The Colorado Cooperative Extension Service maintains an office at Glenwood Springs. The services of a resident Extension Agent, Assistant Extension Agent, Home Demonstration Agent, and the nonresident specialists located on the campus at Fort Collins are available to farmers in the project area.

Additional information and educational services will be required. This is particularly true in connection with any expansion in the dairy and live-stock industry. Some additional information and education in connection with better irrigation water management and pasture development will also be needed.

#### Technical Assistance

The triangular shaped watershed of the Silt project lies within the Bookcliff Soil Conservation District. It includes about 40,000 acres of private lands. The Soil Conservation Service, Glenwood Springs Work Unit, includes the area of the Bookcliff Soil Conservation District. A soil conservationist is resident at Rifle. The unit conservationist at Glenwood Springs furnishes supervision and assistance in soils, engineering, agronomy, woodland and range management. Close working arrangements are maintained with the Forest Service and the Bureau of Land Management.

Additional technical services and on-site assistance from Soil Conservation Service technicians will be required in the planning and application of conservation practices, which will include land leveling, improvement of farm irrigation systems, improved water management, grass management and soil fertility management.

Stream flow forecasts for seasonal flows of Rifle Creek are recognized in the hydrologic study as necessary to the successful management and operation of the Silt project. Installation of two new snow survey courses and a soil moisture station would probably suffice to provide the essential forecast data. Snow-cat or other over-snow transportation would be required to obtain snow course readings. The Soil Conservation Service could provide installation and subsequent operation in accordance





with customary cooperative arrangements between the Service and the Bureau of Reclamation or other interests. Initiation should be at the earliest possible time, since several years operations will be necessary before reliable forecasts can be made.

### Farm Credit and Financing

With the completion of the Silt project, it is anticipated that the demand for Farmers Home Administration services will be increased. This demand will largely be for loans of the soil and water conservation and operating types. Some farm-housing type loans will probably also be requested.

Loans will be used for the establishment of conservation measures such as the enlargement and repair of canal and ditch systems, construction of new ditches, land leveling and other related practices.

The above-mentioned farm improvement measures and farm adjustments will, in many cases, require long-term credit that cannot be supplied by local commercial credit sources. Farmers Home Administration credit programs will be called upon to provide this needed assistance.

### Cost-Sharing for Conservation Measures

Completion of the Silt project will assure an adequate and stable supply of irrigation water to the farms under the project, with subsequent improvement of both rural and urban economy in the community.

The extension of existing laterals and relocation of others will require extensive reorganization of many farm systems to make efficient and economical use of the water.

The Garfield County Agricultural Stabilization and Conservation Committee, whose office is located at Glenwood Springs, offers cost-sharing for needed soil and water conserving measures through the Agricultural Conservation Program to participating farmers and ranches. Projects requiring cooperative effort on the part of groups of farmers acting as single interests may apply for assistance on such projects through the local ASC Committee.

### National Forest Lands

The proposed project features and project lands are all outside the exterior boundary of the White River National Forest. The proposed Rifle Gap Dam and Reservoir will attract visitors to the area and many of these will seek recreational opportunities on adjacent national forest lands.

Restoration, proper management of timber and plant cover, and stabilization of the soil mantle are prime objectives of the White River National Forest. Programs aimed at these objectives are now being carried out and are achieving good results. Construction of the project will add further impetus to early accomplishment of the range improvement, range management, and timber



harvesting aspects of these programs. These activities will aid the general watershed protection objective of reducing floodwater and sediment hazards to project installations and reduce their maintenance.

#### Research Needs

A comprehensive report covering general research needs for the area of the Colorado River Storage Project will be developed by representatives of the U. S. Department of Agriculture research agencies, state agricultural colleges, and experiment stations. As far as the Silt project is concerned, there appear to be no research needs peculiar to this project that would not be covered in the above-mentioned report.



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